California Water Plan Update 2013 -- comments

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1st of 2 e-mails

I am submitting comments today on behalf of the Sanitation Districts of Los Angeles County. I have compiled comments from our staff on various chapters, and, due to the size of some of the files, I will be e-mailing them in two different e-mail submittals. If there are questions regarding any of our comments, please contact me and I will convey the questions to the correct staff. Please contact me or Denise Mays (djmays@lacsd.org) if there are problems with any of the attached files. I would appreciate it if someone is able to send an e-mail indicating receipt of this message.

Thank you!

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California is increasing its integration of municipal recycled water into its water supply portfolio. In some parts of the state, recycled water meets approximately 7 percent of water supply demands. Although the statewide total is an increase since *California Water Plan Update 2009* (Update 2009) was released, it is still far short of previously established goals. Municipal recycled water benefits the state and individual water users by reducing water conveyance needs, providing local water supplies, and being a drought-resistant resource. This resource management strategy (RMS) chapter will describe the current status of recycled water in California, what some of the challenges are to its increasing use, and the resources needed to continue to increase municipal recycled water use.

Introduction

The municipal recycled water RMS addresses the recycling of municipal wastewater treated to a specified quality to enable it to be used again. Within this chapter, the term "recycled water" refers to water that originates from a municipal treatment plant. Treated wastewater is primarily from domestic (household) sources, but it can include commercial, industrial, and institutional (CII) wastewater discharged to a sanitary sewer. This RMS does not address other types of water recycling, such as the reuse of:

- Industrial wastewater, either when internally reused or when treated or disposed separately from municipal wastewater.
- Agricultural wastewater.
- Gray water.

These are addressed in other parts of *California Water Plan Update 2013* (Update 2013).

Changes in this Strategy Since 2009

The Update 2013 municipal recycled water RMS is extensively changed from the version that appeared in Update 2009. There are new or revised policies (the 2009 Recycled Water Policy adopted by the State Water Resources Control Board [SWRCB]), proposed regulations (the California Department of Public Health's [CDPH's] 2011 draft regulations for groundwater replenishment with recycled water, as part of Senate Bill [SB] 918), and a new statewide survey of recycled water users. In addition, several reports that describe recycled water applications, benefits, and challenges have been prepared. Each of these will be discussed within this chapter.

Affiliations with other Resource Management Strategies

Treating and delivering recycled water, as well as disposing of byproducts that may result from generating recycled water, involve issues that may also be discussed in other RMS chapters within Update 2013. The key affiliations of other RMSs to recycled water, shown in Figure 12-1, are described below, by chapter.

- **Chapter 2, "Agricultural Water Use Efficiency"** — Recycled water can be used to irrigate most crops.

- **Chapter 3, "Urban Water Use Efficiency"** — Recycled water can be used for landscape irrigation and commercial or industrial applications. This chapter describes gray water applications.
- **Chapter 6, "Conveyance — Regional/Local"** — Distribution of recycled water is planned and implemented on local and regional levels with local conveyance systems.
- **Chapter 15, "Drinking Water Treatment and Distribution"** — In the future, recycled water may be distributed via potable water distribution systems.
- **Chapter 17, "Matching Water Quality to Use"** — Recycled water could replace many instances where potable water is currently being used for non-potable applications.
- **Chapter 19, "Salt and Salinity Management"** — Recycled water production may result in brine generation. Use of recycled water may also have an overall impact on salinity of the underlying groundwater basin. Discharges of salts and chemicals into sewers from water softeners can increase wastewater salinity and negatively affect municipal recycling.
- **Chapter 20, "Urban Stormwater Runoff Management"** — Stormwater can be used as a water supply mixing source for projects where recycled water is used for groundwater recharge.
- **Chapter 22, "Ecosystem Restoration"** — Recycled water is often a water supply for ecosystem restoration projects.
- **Chapter 24, "Land Use Planning and Management"** — Use of recycled water can be constrained by the availability of sites suitable for recycled water. Successful local planning can encourage locating potential recycled water users where recycled water is available, as well as planning infrastructure needs to support future growth.
- **Chapter 28, "Economic Incentives — Loans, Grants, and Water Pricing"** — Economic incentives are commonly used to initiate recycled water projects, enable infrastructure development, or support the use of lower quality water.
- **Chapter 29, "Outreach and Education"** — Introduction of recycled water as a local water supply resource requires extensive public outreach and education regarding its uses, as well as addressing local water quality and health effect concerns.

PLACEHOLDER Figure 12-1 Municipal Recycled Water Affiliations with Other Resource Management Strategies

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Definition of Municipal Recycled Water

The California Water Code (CWC) provides the following definition for recycled water: "water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefor [sic] considered a valuable resource" (CWC Section 13050(n)). "Recycled water" and "reclaimed water" have the same meaning and can be used interchangeably. The California Water Plan uses the term "recycled water." An illustration of the many paths that municipal recycled water can take for reuse is shown in Figure 12-2. The recycled water pathways shown in this figure do not indicate the level of recycled water treatment. Existing California law specifies required treatment levels for designated uses.

PLACEHOLDER Figure 12-2 Municipal Recycled Water Cycle

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

[This figure will be updated. Current figure is a mock-up.]

Municipal water recycling is a strategy that increases the usefulness of water by reusing a portion of the existing waste stream that would be discharged to the environment as waste and redirecting the water to another local application. This action does not necessarily increase the amount of water in the water supply, but it enables conserving higher-quality water for appropriate uses. Additionally, as a local water source, municipal recycled water can:

- Be an additional water source, possibly offsetting or delaying obtaining additional freshwater supplies.
- Be a drought-resistant water supply.
- Provide an alternative for treatment and disposal of wastewater.
- Reduce overall energy requirements, especially if it is replacing transferred water.
- Reduce discharge of excess nutrients into surface waters.
- Provide nutrients for crops or landscape plants.
- Support environmental habitats, such as wetlands.
- Be used as the water supply for an injection well barrier to control saltwater intrusion.

Recycled water is integrated into California's water supply through both unplanned applications, such as discharge into a stream with a subsequent reuse, or through planned projects. Unplanned reuse occurs when treated wastewater is discharged — usually into a surface water body — and there is no prearranged agreement or intention that the producer would maintain control of the effluent. The downstream reuse can be an environmental benefit by supplementing river flow for wetland or aquatic habitat, or a withdrawal by a downstream river water user. In the case of the latter, the wastewater discharge is regulated to protect the public health for the downstream beneficial user (Recycled Water Task Force 2003).

Planned recycled water projects are developed by water and wastewater suppliers for potable and non-potable uses (Figure 12-3). Non-potable reuse includes any application not involving drinking water for human consumption, such as landscape or agricultural irrigation, commercial applications like car washes or dual-plumbed office buildings, or industrial process such as oil refineries or cooling towers. Potable reuse results in augmentation to drinking water supplies, and it can be either direct or indirect. Direct potable reuse is treated water conveyed directly from the wastewater treatment plant to the drinking water supply lines. Indirect potable reuse is treated water from the wastewater treatment plant discharged into recharge basins to infiltrate into groundwater aquifers or into surface water reservoirs used for drinking water supply. Because seawater intrusion barriers typically result in groundwater recharge, they are considered a form of indirect potable reuse.

PLACEHOLDER Figure 12-3 Potable and Non-Potable Municipal Recycled Water

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Water discharged from a wastewater facility may still be reused even if it is not a planned action, as shown in Figure 12-2. Typically, treated wastewater is discharged into rivers and streams as part of permitted disposal practices. Discharged water then comingles with the stream or river that may be a water source for downstream communities or agricultural users. When a downstream entity withdraws water from the stream, a portion of that water is treated wastewater from an upstream discharge that has comingled with the ambient stream flow. Estimates from California Water Plans prepared in the 1980s indicated that between 86 percent and 100 percent of wastewater discharged in Central Valley hydrologic basins at the time was indirectly reused in this manner. Comingling of recycled water also occurs when it is used to recharge existing groundwater supplies (see Figure 12-2).

Treated wastewater can also be discharged to the ocean or other saline water bodies. This water usually is considered no longer practically available for reuse and is referred to as “irrecoverable water.” The State recognizes recycling projects that capture municipal wastewater in coastal areas that would otherwise become irrecoverable water as providing “new water” supply. An estimated 0.9 million to 1.4 million acre-feet (af) per year (af/yr.) of “new water” could be realized by 2030 through recycling municipal wastewater that is discharged into the ocean or brackish bays (Recycled Water Task Force 2003). Because discharges to the ocean or brackish water bodies support few, if any, downstream beneficial uses, such discharges are excellent sources of wastewater for future recycling efforts (Recycled Water Task Force 2003). These projects may also support energy-efficient water supply strategies because they more fully utilize the energy already expended to treat the water to disposal levels that would otherwise be discharged to irrecoverable sources.

An additional consequence of increasing direct municipal recycled water use is that the volume of water discharged into streams may be reduced, potentially adversely affecting downstream water rights or instream beneficial uses. Recognizing this, the CWC requires that prior to making any change in the point of discharge, place of use, or purpose of use of treated wastewater, the SWRCB review potential changes to ensure potential impacts on beneficial uses are considered before authorizing a change in the permitted discharge of municipal wastewater (CWC Section 1211).

Recycled Water Use in California

Continued integration and expansion of recycled water into California’s water supply options are necessary to support meeting future demands despite uncertain climactic conditions. Language recognizing the importance of recycled water in meeting future water demands is included in State law: “It is hereby declared that the people of the state have a primary interest in the development of facilities to recycle water containing waste to supplement existing surface and underground water supplies and to assist in meeting the future water requirements of the state” (CWC Section 13510). The state reinforces this declaration by stating in the CWC that under certain conditions the use of potable water for nonpotable purposes is a waste or unreasonable use of water if recycled water is available (California Water Code Section 13550 et seq.). This has been the basis for the past several decades in California for encouraging recycled water for non-potable uses, especially for industrial and irrigation applications.

Several important actions involving municipal recycled water have occurred (or are in process) since the 2009 update of the California Water Plan. These include:

- Completion of the 2009 Municipal Wastewater Recycling Survey through a joint effort by the SWRCB and the California Department of Water Resources (DWR).

- The SWRCB's adoption of the Recycled Water Policy in 2009.
- CDPH 2011 release of draft regulations for groundwater replenishment with recycled water.
- California Public Utilities Commission (CPUC) release of its Recycled Water Policy Framework for Investor-Owned Utilities.

This section addresses past and current water recycling in the state, as well as each of the important actions involving municipal recycled water.

History of Recycled Water in California

Municipal recycled water has been used beneficially in California for more than 100 years. In the earliest applications, farms located near urban areas in this drought-prone state used effluent from municipal wastewater treatment plants. By 1910, 35 sites were using municipal recycled water for agriculture purposes. From 1932 to 1978, San Francisco's McQueen Treatment Plant, the first documented California treatment facility dedicated to treating recycled water (RMC Water and Environment 2009), supplied recycled water for irrigation in Golden Gate Park.

In 1952, 107 California communities were using municipal recycled water for agricultural and landscape irrigation. Following a national initiative to upgrade and improve the level of wastewater treatment in the 1970s, the uses of municipal recycled water applications began to diversify. Beneficial uses of California's recycled water now include landscape, agricultural, and golf course irrigation; commercial and industrial applications; environmental enhancement; groundwater recharge; and lake augmentation.

Current Recycled Water Use in California — the 2009 Survey

Statewide surveys conducted since 1970 quantified annual volumes of municipal recycled water use and have shown a steady increase in the amount and types of uses (Figure 12-4). These surveys accounted for only planned reuse with recycled water delivered directly to users or to groundwater recharge facilities. For the calendar year 2009, the SWRCB and DWR conducted a survey of agencies involved with the treatment, conveyance, or beneficial reuse of domestic wastewater as recycled water. The survey results identified 669,000 af of treated municipal wastewater that were beneficially reused in California in 2009, classified according to 11 beneficial uses (State Water Resources Control Board 2012). Beneficial uses in the 2001 and 2009 recycled water surveys, as well as historical uses, are shown in Figure 12-5. Indirect potable reuse by adding recycled water to reservoir drinking water supplies and direct potable reuse do not currently occur in California. As part of SB 918 (covered later in the chapter), the California Department of Public Health (CDPH) will investigate the feasibility of developing water recycling criteria for direct potable reuse in California.

PLACEHOLDER Figure 12-4 Municipal Recycled Water Use in California Since 1970

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

PLACEHOLDER Figure 12-5 Changes in California's Recycled Water Beneficial Uses

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Recycling of municipal wastewater occurs throughout California (Figure 12-6). Only seven of the state's 58 counties do not have identified recycling projects. In general, the highest countywide volumes of recycled water occur in parts of the state where local water resources are strained, population densities are high, or wastewater disposal is problematic (Figure 12-7).

PLACEHOLDER Figure 12-6 Municipal Recycled Water Use by County in 2009

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

PLACEHOLDER Figure 12-7 Regional Variations in Beneficial Uses of Municipal Recycled Water in 2009

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

The 2009 Municipal Wastewater Recycling Survey identified 210 recycling systems, directly involving almost 300 agencies in some aspect of recycling municipal wastewater in the state. These projects ranged in size from less than 50 af to more than 86,000 af in 2009, and involved many levels of complexity, from direct agricultural reuse to multiple levels of treatment and agency involvement. These projects were funded by local water suppliers, customers, and state or federal grants and loans obtained through individual or integrated regional water management (IRWM) funding applications.

Potential Recycling in 2020 and 2030

How much water will California be able to recycle in the future? Various future recycled water goals and mandates have been developed by State agencies (Table 12-1), but to date they have not been met. To establish achievable targets, DWR reviewed recycled water use projections included in 2010 urban water management plans (UWMPs), which are required to be prepared by urban water suppliers providing more than 3,000 af annually or having more than 3,000 service connections. UWMPs are discussed more in Chapter 3 of this volume, "Urban Water Use Efficiency."

PLACEHOLDER Table 12-1 Recycled Water Statewide Goals and Mandates

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Using the data from the 2009 Municipal Wastewater Recycling Survey and the UWMPs, DWR estimates that the 2020 and 2030 targets for statewide municipal water recycling should be established at 1,000,000 and 1,300,000 af. No recommendations are made to modify the existing goals or mandates (California Department of Water Resources 2013b). Achieving these new targets would require identifying new opportunities for reusing California's water resources. California's uses of recycled water have diversified over time (see Figure 12-5) and are expected to continue increasing as water resources are more constrained and as people become more knowledgeable about water reuse. Local water suppliers are assessing opportunities for indirect and direct potable reuse of highly treated recycled water as a way of augmenting and "drought-proofing" local supplies, as well as expanding existing irrigation and industrial applications.

The recycled water community is also placing greater emphasis on matching wastewater treatment levels to water quality requirements for the planned reuse, referred to as "fit for purpose" (U.S. Environmental Protection Agency 2012). This concept is where more rigorous treatment (and more energy-intensive processes) is reserved for uses with higher human or food production contact to minimize pathogen or chemical of emerging concern contact. Conversely, less-treated wastewater has been safely used for decades in many agricultural reuse applications, which is the largest category of recycled water use in California. Greater reuse of secondary-treated wastewater in agriculture and environmental settings, where additional "natural treatment" can augment wastewater plant treatment, may provide additional opportunities for meeting the newly established 2020 and 2030 recycled water targets. Finally, water suppliers may determine that having available multiple levels of treated wastewater may support increased integration of recycled water use into their water supply portfolio. West Basin Municipal Water District is very successfully providing multiple water quality levels of recycled water to its customers to meet specific needs of its diverse customer base.

Tracking the State's success in increasing use of recycled water and achieving identified goals, targets, and mandates would require conducting future recycled water surveys. Collection of actual recycled water use data in a manner consistent with approaches used in previous recycled water surveys will facilitate monitoring progress. However, completing a voluntary recycled water use survey using the existing methodologies is a labor-intensive effort. Initial discussions are under way to identify more efficient data collection approaches using mandatory, electronic reporting. Because of the complexity of recycled water producers, wholesale and retail agency, and end user relationships, any electronic reporting mechanism will have to be coupled with expert review and compilation of data to avoid missing or duplicating data in surveys.

Recycled Water Use Policies, Regulations, Responsibilities, and Funding

As the treatment level of municipal wastewater increases from primary to secondary, tertiary, or advanced, the permitted uses of recycled water increase. State policies and regulations are in place to increase the use of recycled water in a manner that is protective of human and environmental health. State regulations mandate that producers and users of recycled water comply with treatment and use restrictions to protect public health and water quality.

In general, the levels of treatment for recycled water use are based on levels of human exposure and pathways of exposure leading to infection. The required levels of treatment are specified in Title 22 of the California Code of Regulations (CCR) (Division 4, Chapter 3, Section 60301 et seq.). The Title 22 regulations also specify monitoring and reporting requirements and on-site use area requirements. For example, municipal wastewater that has completed tertiary treatment can be used to irrigate school yards, parks, ~~and~~ residential landscape and may be suitable for industrial applications or use in office and institutional buildings for toilet flushing. Wastewater that has been treated to secondary levels is generally suitable for uses that do not include contact with people or unprocessed food crops, such as agricultural irrigation of animal feed crops. The treatment to serve these special needs is not governed by Title 22 regulations.

Aside from the need to protect human health, there are special water quality needs for uses in agriculture or industry to grow crops or manufacture products. Higher levels of treatment may be needed for some industrial applications. Some agencies are able to provide multiple levels of recycled water treatment for various customer uses.

Recycled Water Roles

The current framework for regulating municipal recycled water has been in place since the 1970s. As established in State law, primary authority for overseeing municipal recycled water is divided between the SWRCB, including the nine regional water quality control boards (RWQCBs), and the CDPH. A memorandum of agreement between the two agencies documents this arrangement and clarifies the roles of the agencies. The CDPH regulates public water systems and sets standards for wastewater reuse to protect public health by adopting water recycling criteria based on water source and quality and by specifying sufficient treatment based on intended use and human exposure. The treatment objective is to remove pathogens and other constituents, making the water clean and safe for the intended uses. The SWRCB, through the RWQCBs, has the roles of permitting and providing ongoing oversight authority for water recycling projects. The permits incorporate applicable CDPH Title 22 requirements and specify approved uses of recycled water and performance standards.

Four other state agencies are directly involved with municipal recycled water issues in California and implement various sections of State law: DWR, the CPUC, the California Department of Housing and Community Development (HCD), and the California Building Standards Commission (CBSC). Statutes governing municipal recycled water are currently contained within the CWC, the California Health and Safety Code, the California Government Code, the Public Resources Code, and the Public Utilities Code, and regulations are in various subdivisions (titles) of the CCR. State agency roles and responsibilities are summarized in Table 12-2.

PLACEHOLDER Table 12-2 State Agency Recycled Water Roles and Responsibilities

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In addition to the statewide agencies, local city and county officials also have a regulatory role affecting municipal recycled water projects. In some cases, the CDPH can delegate responsibilities to local officials if local sponsors of municipal recycled water projects agree with the delegation.

Recycled Water Use Statutes, Regulations, and Policies

Since the 1970s, various statutes, regulations, and policies have been enacted and developed to address recycled water generation and use. Table 12-3 highlights some of them. Additionally, there are several new and pending regulations, which are discussed here. The following discussion is based on conditions in early 2013. Some revisions to State statutes have been introduced into the Legislature to consolidate and streamline existing recycled water laws to facilitate uniform implementation.

PLACEHOLDER Table 12-3 Important Recycled Water Policies and Regulations

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Recycled Water Policy of 2009

In 2009, the SWRCB adopted the Recycled Water Policy to address issues of concern for permitting recycled water and protecting water quality, including salinity management, regulation of incidental runoff, and monitoring and regulation of chemicals of emerging concern. The policy (State Water Resources Control Board 2009b) calls for managing basins or subbasins through stakeholder involvement and implementation of salt and nutrient management plans and regulating incidental runoff through waste discharge requirements and best management practices. It also prioritizes approval of groundwater recharge projects utilizing municipal recycled water treated by reverse osmosis.

The policy was modified in 2013 to incorporate science advisory panel recommendations (State Water Resources Control Board 2010) on monitoring chemicals of emerging concern. Chemicals of emerging concern are new classes of chemicals in the environment — such as pharmaceuticals, currently used pesticides, and industrial chemicals — that could have adverse aquatic and human health effects and for which there is less toxicological information than there is for chemicals that have been longer used and studied. These chemicals have the potential to be present in recycled water, which is why the SWRCB convened the scientific panel and modified the Recycled Water Policy to address monitoring requirements for chemicals of emerging concern in certain types of recycled water projects.

Senate Bill 918

SB 918 was enacted in 2010 and focuses on the issues of indirect and direct potable reuse. It requires CDPH adoption of uniform water recycling criteria for indirect potable reuse for groundwater recharge in 2013 and surface water augmentation in 2016. It also requires the CDPH, by the end of 2016, to investigate and report to the Legislature on the feasibility of developing uniform water recycling criteria for direct potable reuse. The CDPH is required to convene an expert panel to advise it on the development of criteria for surface water augmentation and the feasibility of direct potable reuse.

The current Title 22 regulations provide that requirements for groundwater recharge projects using recycled water will be determined on a case-by-case basis. With the aim of adopting uniform statewide regulations, draft groundwater recharge regulations have been in place since the mid-1980s. They have evolved over time, incorporating experience with ongoing projects and new scientific information.

In November 2011, the CDPH released revised draft regulations addressing groundwater replenishment using recycled water from domestic wastewater sources, for aquifers designated as a source of drinking water. In December 2011, the CDPH held workshops throughout the state and requested written comments from all interested parties. The CHPH has reviewed the comments and anticipates releasing a revised draft in spring 2013. The proposed regulations would replace the existing case-by-case regulations. Through SB 918 (2010), CWC Section 13562 requires the CDPH to adopt revised groundwater replenishment regulations by Dec. 31, 2013. However, it is unlikely this deadline will be met, because the CDPH has not received the additional resources necessary to meet the deadline in SB 918. Nevertheless, proposed groundwater replenishment (and surface water augmentation) projects continue to move forward.

The proposed groundwater recharge regulations seek to protect public health for projects utilizing indirect reuse of recycled water to replenish drinking water basins, by establishing criteria that cover:

- Source water control.
- Potential risks associated with pathogenic microorganisms, regulated contaminants, and unregulated contaminants.
- Effective natural barriers and multiple treatment barriers.
- Ongoing monitoring of recycled water and groundwater.
- Effective treatment processes.
- Time to identify and respond to failures.
- Review, reporting, and notification processes.

Recycled Water Policy Framework for Investor-Owned Utilities

The CPUC is in the process of developing a comprehensive policy framework to cover recycled water projects, production, and recycled water use for the investor-owned water and sewer utilities that it regulates. This action, required under the CPUC's Order Instituting Rulemaking 10-11-014, applies to investor-owned utilities with a customer base of 2,000 or more connections. The goal of the policy framework is to facilitate the cost-effective use of recycled water where it is available or can be made available and to reduce the barriers to collaboration between wholesalers and retail recycled water purveyors. The policy framework is expected to provide guidance to investor-owned water and sewer utilities that are in a position to identify, evaluate, and pursue opportunities to add recycled water to water supply portfolios. The policy framework will take into account the most recent State policy and legislation for the production, delivery, and use of recycled water and will encourage interagency coordination and collaboration in the implementation of these policies.

Recycled Water Use Funding

Recycled water projects are funded directly by local water agencies and water users through rates, bonds, or rebates. Individual water users may also pay for projects that directly benefit them, such as an industrial facility installing on-site or off-site infrastructure to receive recycled water or implementing a process modification. Local agencies take the lead in identifying, analyzing, and prioritizing the water resource projects in their jurisdictions to help achieve their identified goals. They then proceed with the best option to implement their identified projects. Once projects are constructed, revenue from the sale of recycled water, revenue from the sale of potable water, and tax assessments are options for operation, maintenance, and debt service financing.

Other funding options include obtaining grants or loans from both State and federal sources, including the sources listed below.

- **IRWM Grant Program**, administered by DWR. The IRWM grants (funded by Proposition 84) are used by communities in IRWM regions to implement water supply and management projects. Water recycling is one of many strategies that may be considered by IRWM regions in developing their water resource management portfolios.
- **Water Recycling Funding Program**, administered by the SWRCB. This program provides low-interest financing and grants to local agencies (funded by a variety of sources, including Proposition 13). Water recycling is a key objective in the SWRCB's *Strategic Plan Update 2008-2012* (State Water Resources Control Board 2008), which identifies priorities and direction for the SWRCB and its nine RWQCBs.
- **Clean Water State Revolving Fund**, administered by the SWRCB (and funded by the federal Clean Water Act and State bonds). This program provides low-interest financing primarily for wastewater collection, treatment, and disposal, but it also funds recycling projects.

- **Title XVI,** administered by the U.S. Bureau of Reclamation. This federal program (authorized by Title XVI of Public Law 102-575) funds water reclamation and reuse projects throughout the western United States.

With State budget constraints, it is likely that additional sources of funding will be limited in the future. This is a challenge, because implementation of recycled water projects often requires significant capital outlay, which many water suppliers are not able to fund without outside resources. However, given the importance of a reliable water supply to the state's economy, legislative support of providing additional funding for recycled water projects is a critical component of continued recycled water development.

Later in this chapter, the subsection "Affordability" describes sharing costs, regional approaches, planning considerations, and actions that could support implementation costs.

Potential Benefits

Water recycling provides many benefits to local and statewide water supply reliability. Municipal recycled water increases local supplies, supports drought preparedness, mitigates climate change effects, provides environmental benefits, and can reduce energy consumption by lowering dependence on imported supplies.

Local Supply

Municipal recycled water has the advantage of being locally generated and reused. The availability of additional local supplies can provide resource-limited communities with additional options for meeting water supply demands. Areas with constrained or declining groundwater supplies or heavy dependence on imported water may realize significant benefit from appropriate reuse of treated municipal wastewater. Recycled water may provide more cost-effective water self-sufficiency options than other resource development alternatives. It can also provide additional water resources to address increased demands from population growth.

Drought Preparedness

Establishing recycled water capacity provides a more reliable water supply resource for water managers to access during drought cycles. Municipal recycled water as a water supply has less variability than traditional resources because domestic water disposal continues even during droughts. Wastewater production will decrease during a drought as households and commercial and industrial facilities conserve, but some wastewater generation will still occur.

Climate Change

Climate change is expected to increase atmospheric temperatures, resulting in a more variable precipitation regime and declining snowpack (California Department of Water Resources 2008). Consequences of the warming climate are anticipated to reduce water resource supply and increase water demand for urban, agricultural, and environmental uses, with a concurrent reduction in water supply availability and reliability.

Municipal recycled water will contribute to sustainability for urban water supplies facing changing climate conditions, particularly where local water supplies are limited. As a source of water for groundwater recharge, recycled water can support climate change planning. Groundwater basins and aquifers have the potential to store significant amounts of water from a variety of sources, potentially including stormwater and treated wastewater for later recovery. The use of recycled water to recharge groundwater basins can address climate change adaptation:

- Wastewater discharges represent a potential source of additional water that is currently underutilized or not utilized.
- Groundwater recharge provides a practical storage solution.

As stated earlier, the CDPH has proposed draft regulations for the use of recycled water for groundwater recharge.

Energy Savings

Implementing municipal water recycling could reduce energy consumption, which may also support California's climate change mitigation efforts. Combustion of fossil fuels at power plants is a major source of greenhouse gas (GHG) emissions. The water sector uses a significant amount of the energy produced by those power plants, especially for the conveyance of water from its source to its use. Water recycling can provide a lower-energy source of local water compared with importing water from other regions and desalination of ocean water or brackish waters. Energy savings are greatest when recycled water is used in close proximity to wastewater treatment sources and when additional treatment is not required beyond the treatment needed for wastewater disposal.

Recycled water used for most urban applications requires tertiary treatment, which requires a greater amount of energy and reduces the potential GHG savings. However, in many cases, tertiary treatment is required to protect public health or the environment when wastewater is discharged to streams. In such cases, to take the further step to recycle the wastewater for urban uses, it is necessary only to install infrastructure to convey the recycled water to end users. The energy and GHG emissions associated with tertiary treatment are allocated to pollution control and environmental protection, and the energy and GHG emissions associated with conveyance are allocated to the water supply function of water recycling.

Energy savings realized by implementing a recycled water project depend on multiple factors, including the source of the water offset by the recycled water and the amount of increased treatment above disposal needed to reuse the water. Research is also ongoing to develop lower-energy recycling methods, which would in turn reduce the GHG generation during the water recycling process. Overall, it is assumed that implementing recycled water would provide energy use benefit by developing local resources versus importing fresh water.

Potential Costs

Augmenting statewide municipal recycled water funding, even in light of current statewide budget issues, is a long-term benefit because it develops local, reliable water supplies. The costs to implement recycled water projects vary based on the amount of water to be treated, treatment requirements, infrastructure needs, project planning, permitting, and financing. As a result, project costs can vary widely, as described further below.

Overall Costs

California's Recycled Water Task Force (2003) estimated that between 2003 and 2030, an additional 1.4 million to 1.7 million af of additional wastewater could be recycled annually in California, based on growth in available wastewater and increased percentage of wastewater recycling. Of this, 0.9 million to 1.4 million af (62 percent to 82 percent) of the additional recycled water would be from discharges that would otherwise be lost to the ocean, saline bays, or brackish bodies of water (Recycled Water Task Force 2003). To add 1.4 million to 1.7 million af per year of recycled water, the task force estimated that a capital investment of between $9 billion and $11 billion would be required (in 2003 dollars) (Recycled Water Task Force 2003). This amount would be the incremental capital cost above the cost of wastewater treatment for discharge to a water body.

Given the variability of local conditions and their effect on treatment and distribution costs, the current estimated range of capital and operational costs of water recycling range from $300 to $1,300 per af of recycled water, but in some instances costs are above this range. The upper end of the current unit costs for recycled water projects comes from cost estimates recently prepared for two Southern California projects, in San Diego and Oxnard. Costs per af for those projects are estimated to be between $1,191 and $1,900 (Fikes 2012; Wenner 2012). These are urban projects and are reflective of higher-end projects, as well as the increasing costs of implementing recycled water projects. Therefore, for planning purposes, the State should consider that overall costs to reach the Recycled Water Task Force potential estimate will be at the higher end of the estimate range, if not beyond this.

Increased focus on matching water use to water quality is an approach to implement more cost-effective projects while attempting to lessen ratepayer impacts for these projects. In a state where between 70 percent and 80 percent of developed water is used for agriculture, projects that can convey secondary effluent to agricultural users and develop cooperative solutions could be a cost-effective way to meet water resource needs. Overall, the actual cost of recycled water projects will depend on the quality of the wastewater, the level of treatment required, the proximity of potential users to the sources of recycled water, and user costs associated with required upgrades or operational modifications. Uses that require higher water quality or have greater public health concerns, or both, will incur higher costs.

The cost to install new distribution systems is a major obstacle to the expansion of water recycling. Assessing costs of implementing recycled water programs should consider not only the cost of municipal infrastructure and its operation and maintenance, but also the cost to users. In particular, larger industrial, agricultural, or commercial users that may need on-site modifications to maintain a separate water system, including physical barriers for backflow prevention, or process modification to utilize a different water quality. In addition, a user may have additional operating costs for recycled water use as that user integrates recycled water into its water supplies.

Because recycled water is not classified as potable, regulatory constraints prohibit conveying recycled water and potable water in the same pipelines. Under current regulations, recycled water must be conveyed in a separate purple pipe distribution system that is labeled and readily distinguished from potable water lines. The cost to install new purple pipe distribution mains from treatment plants to users can exceed the costs of obtaining alternate water sources or projects — including, in some cases, the cost of potable reuse projects. As a consequence, extension of purple pipe systems to areas near treatment plants can be more cost-effective than extending infrastructure and service to more distant users.

Distribution system cost can be an obstacle when evaluating the feasibility of supplying recycled water to large numbers of users or users more distant from urban wastewater treatment plants. Some water agencies have constructed satellite water recycling facilities to provide recycled water at locations near large concentrations of use.

How cost is a potential issue to increasing recycled water use in California is discussed further in the next section.

Individual User Costs

Additional costs that individual recycled water users may need to incur to receive recycled water include installing dual plumbing, modifying facility processes to use water of a different quality, and implementing cross-connection prevention. These can be significant cost components to potential recycled water customers using both potable and non-potable water.

Cross-connections, the accidental direct contact between potable and non-potable water systems, can contaminate potable water systems. Air gaps, valves, or other controls are installed to prevent cross-connections because of inadvertent pipe connections, pressure loss, or other failures. Specific requirements vary by the water supplier or governmental agency. State regulations to protect public potable water systems from contamination by non-potable water are in CCR Title 17 adopted by the CDPH.

The California Plumbing Code specifies protections to prevent potable water lines on the property of users from contamination. Its provisions governing dual plumbing in buildings were adopted in California in 2009. These codes established statewide standards to install both potable and recycled water plumbing systems in commercial, retail, and office buildings; theaters; auditoriums; condominiums; schools; hotels; apartments; barracks; dormitories; jails; prisons; reformatories; or other structures as determined by the CDPH. Some potential recycled water customers have faced challenges working with local inspectors to implement dual-plumbed systems, but these issues are expected to decrease as the systems become more common.

Major Issues

There are many issues involved in planning and implementing recycled water projects. However, based on the many successful projects in California, potential obstacles are not insurmountable. Awareness of potential issues and sound planning practices to address or prevent negative impacts are key components of successful project development. Successfully implemented projects have also included early involvement of affected agencies, potential recycled water customers, other stakeholders, and representatives of public interests.

Identifying and planning successful approaches to issues that could hinder the implementation of increasing recycled water use both locally and statewide is critical for continued growth. The Recycled Water Task Force (2003) identified 26 recycled water “issues, constraints, and impediments” and provided recommendations to address them. More recently, three efforts conducted since Update 2009 addressed issues (also referred to as barriers or challenges) facing increased municipal recycled water use. These efforts were:

- *Integrated Water Resources Plan: 2010 Update* (Metropolitan Water District of Southern California 2010).
- *Draft Commercial, Institutional and Industrial Task Force Water Use Best Management Practices Report to the Legislature* (California Department of Water Resources 2013a).
- *Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater* (National Research Council 2012).

Input from these documents supported development of the issue discussions included in this section. As part of future recycled water planning, a comprehensive review of the Recycled Water Task Force recommendations, in coordination with these more recently completed efforts, would provide guidance to DWR and the recycled water community on prioritizing future actions.

The issues addressed below are commonly confronted in planning and developing local and regional recycled water projects. DWR (and other State agencies directly involved with recycled water) will support local efforts by preparing applicable statewide recycled water planning documents. This will include reviewing the National Research Council's recommendations (2012) and other applicable documents (e.g., National Water Research Institute 2012) and integrating those that are applicable to California.

Affordability

The affordability of recycled water has to be viewed from various perspectives, such as those of agencies implementing recycled water projects, users of recycled water, suppliers of potable water whose revenue may be affected by recycled water use, and sewer and potable water ratepayers who may see their rates affected by recycled water use. The costs of recycled water projects may include: additional treatment above current wastewater treatment, disposal of treatment byproducts, storage and pump facilities, and recycled water pipeline distribution systems. In addition, there may be on-site costs at user sites for specialized treatment of the recycled water, including on-site plumbing, cross-connection control devices, and potential modification of commercial or industrial processes to accommodate recycled water. The responsibility for payment of these costs depends on sources of revenue or financial assistance and how agencies agree to share costs based on the perceived beneficiaries.

The common reference point for water suppliers and users is what they currently pay for alternative water sources, such as potable water, or what agencies will have to pay in the future for new water supplies. Water suppliers in California are often dependent on other wholesale suppliers for their water supply. Prices for water often are set to recover costs from past projects and do not reflect the more expensive costs of new water supplies. Thus, prices are not a good benchmark for the true economic cost of new water supplies. New freshwater supplies are often developed at the regional or state level, whereas recycled water projects are often developed at the sub-regional or local level. It is difficult for any one water supplier or user to see the total water supply picture from the standpoint of costs.

Much of the water provided by federally funded projects is provided at discounted prices. Artificially low rates discourage adoption of water recycling and similar conservation programs. Consequently, there is growing recognition that pricing should more closely reflect the true costs to provide water and thus encourage more efficient use of existing water supplies. As stated in the National Research Council's 2012 report on national water recycling, "Current reclaimed water rates do not typically return the full cost of treating and delivering reclaimed water to customers." Water pricing issues need to be considered early in the planning process for recycled water and thoroughly vetted with potential customers.

Some benefits or costs can be difficult to quantify and, even though real, are accrued indirectly such that they are not reflected in project costs. Recycled water has a benefit of reliability during droughts, but the monetary benefit accrues to the general economy and not to water suppliers. ~~There may be a water quality benefit to reusing water instead of discharging treated wastewater into a river.~~

Economic tools can provide a quantification of many indirect costs and benefits, and a methodology called an economic analysis can be used to compare recycled water and other water projects on an equal basis by looking at total costs and benefits to society as a whole. When economic analysis finds recycled water to be cost-effective compared with alternative water supplies, the challenge should then be to allocate costs according to beneficiaries and to use financial incentives, such as regional rebates or State and federal loans and grants, to encourage local water suppliers to build recycled water projects.

Interagency cooperation can be a way to allocate costs according to beneficiaries and to achieve multiple objectives. Recycled water can improve regional water reliability and offset potable water that can be used in other areas. Regional water supplier partners can help local recycled water projects by contributing to construction and operation costs reflecting the regional benefits. Because of high initial infrastructure costs, many California communities are developing cooperative recycled water projects. These projects are developed and implemented locally to best serve the local needs. Projects have been developed where one community provides wastewater to another that then treats it to recycled water standards and distributes it. Another institutional arrangement involves a wastewater agency producing recycled water and a partnering water agency distributing it.

Advancements in water recycling treatment technology may bring down costs in the future, especially for indirect and, potentially, direct potable reuse, where high levels of treatment are often required. Another way of reducing costs is to incorporate purple recycled water pipelines in new developments at the same time as potable water lines are being installed. Long-range planning can anticipate where future recycled water users should be.

Nevertheless, dedicated recycled water distribution systems are costly. Adding recycled water to sources of drinking water (e.g., aquifers or surface reservoirs) eliminates the need for dual distribution systems. Introducing highly treated recycled water directly into potable water pipelines could also eliminate the need for separate recycled water lines. Groundwater recharge is widely practiced in California, but suitable aquifers are not available everywhere. Indirect potable reuse by augmenting surface drinking water reservoirs with recycled water and direct potable reuse are currently not allowed in California, but such practices would give communities more flexibility in how recycled water could be used at potentially lower cost than non-potable reuse through separate recycled water pipelines. SB 918 established a schedule for the CDPH to evaluate surface water augmentation and adopt regulations and to evaluate direct potable reuse and report to the Legislature.

The availability of local funding sources continues to challenge the implementation of new projects or the expansion of existing projects. Where a recycled water project is found to be cost-effective from an evaluation of all costs and benefits from society's perspective, but more expensive than alternatives from a local perspective, there is a role for regional, State, and federal financial assistance to encourage the optimum water resource solution. The primary source of State funding has been the Water Recycling Funding Program administered by the SWRCB, which provides low-interest loans and grants to local agencies. DWR administers the IRWM Grant Program. Water recycling is an RMS that must be considered by an integrated regional water management plan (IRWMP) and may be utilized as an active component of the plans to help a region meet water management goals and objectives. Inclusion of wastewater agencies in the IRWM process will facilitate the identification of municipal recycled water projects as viable water supply projects and facilitate the interaction of water and wastewater agencies to identify mutually beneficial solutions to common issues. Water recycling projects identified in IRWMPs to be a key strategy may qualify for IRWM grant funding. The federal government, through the U.S. Bureau of Reclamation, has been a major contributor of grants and loans to recycling projects in California, primarily through the Title XVI program.

Water Quality

Water quality criteria for recycled water, established by the CDPH, define water quality and treatment requirements to protect public health for most expected uses of recycled water. RWQCBs establish water quality requirements to protect the beneficial uses of surface and groundwater bodies. Under current regulations, RWQCBs issue the waste discharge or water reclamation permits to recycled water producers, distributors, and users. These permits incorporate water quality and monitoring requirements for recycled water projects, including health department criteria to protect public health and any site-specific requirements for protecting water quality.

Recycled water quality is to protect environmental and human health in order to support current uses and long-term sustainability. Recycled water quality issues include:

- Pathogen content (primarily bacteria and viruses).
- Salinity.
- Nitrogen compounds.
- Heavy metals.
- Organic and inorganic substances (often of commercial and industrial origin, but also pharmaceuticals and personal care products, household chemicals and detergents, fertilizers, pesticides, fungicides, and hormones), including chemicals of emerging concern.

Chemicals of emerging concern, described earlier in this chapter within the section about the Recycled Water Policy, are found in wastewater and may occur in recycled water at very low concentrations. Research is ongoing regarding potential impacts of chemicals of emerging concern in recycled water, particularly with respect to effects on human health or the environment. Currently, there are no established regulatory limits for chemicals of emerging concern, but some monitoring is required by the CDPH and the SWRCB as a precaution for protection of human health and the aquatic environment.

The SWRCB's expert panel on chemicals of emerging concern (State Water Resources Control Board 2010) provided recommendations, based on available information, for constituents to be included in required monitoring of various types of recycled water projects. These recommendations have been incorporated into the Recycled Water Policy. As additional information becomes available, future changes can be made to regulations and policies to protect California's water resources while supporting implementation of new projects.

The Recycled Water Policy encourages the development of salinity and nutrient management plans. These plans address salinity and nitrogen issues, including changes that may occur with the use of recycled water. Therefore, implementation of a recycled water program may be enhanced by the parallel development of a salinity and nutrient management plan. In addition to water quality being protective of human and environmental health, aligning water quality to end use is a key component of recycled water planning and implementation (see Chapter 17 within this volume, "Matching Water Quality to Use"). The planned end uses and commercial/industrial application compatibilities are crucial recycled water considerations. In many cases, recycled water is integrated into existing processes. Most commercial and industrial applications are sensitive to water quality, and recycled water typically has more minerals and organic content than many available alternative supplies. Subtle changes in water quality, such as increases or decreases of certain minerals or chemical species, can dramatically change the suitability of recycled water or the treatment requirements for use in an industrial process. Many water quality concerns associated with recycled water can be and are addressed with additional treatment by the water utility, on-site treatment, or other water management practices. These additional efforts have to be considered during recycled water planning, along with financial impacts and responsibilities.

Public Acceptance

Public acceptance of recycled water projects is critical for their success. Water quality and cost factors are two issues often raised by the public. Integrating public input into the project planning phase has been a successful approach for many agencies.

In general, there is public acceptance and support for most non-potable recycled water applications, such as agricultural and landscape irrigation, where there is a lower degree of direct human exposure. Public acceptance can be lower for projects with more direct links between recycled water and human consumption or contact. A factor that may raise some public concern is a perceived conflict between assurances that recycled water is safe and the necessity of regulations to protect the public from misuse. Outreach, education programs, and involvement during project planning can provide public reassurance that recycled water is adequately regulated to protect public health.

Environmental buffers — natural processes separating treated recycled water from human end uses — frequently enhance public acceptance of recycled water projects and differentiate indirect and direct potable reuse, as explained earlier. For example, public concern about mixing recycled water with groundwater appears to be partly alleviated when infiltration, percolation, and underground residence time expose the water to natural cleansing processes after engineered treatment. The actual benefit of environmental barriers versus engineered treatment with system controls has not been fully quantified. Additional research and planning may support how environmental buffers and engineered controls are perceived by the public and implemented in future projects.

Impacts on Downstream Users

Communities that discharge wastewater to rivers and streams contribute to the ambient water available for use by downstream users. The implementation of water recycling in upstream communities would reduce the volume of such discharges, potentially reducing the volume of ambient water available for downstream reuse or fulfillment of environmental needs. In some circumstances, downstream users may have rights to the use of discharged wastewater, potentially preventing upstream communities from implementing recycling.

In the case of groundwater recharge with recycled water, the availability of groundwater downgradient may be increased, but there may be water quality impacts. Whether for storage or planned indirect use, the discharge of recycled water to wells, infiltration sites, or other locations underlain by permeable soil and geologic materials has the potential to introduce contaminants, including salts, into potable groundwater sources and aquifers. Modern microfiltration, reverse osmosis, and disinfection practices produce exceedingly high-quality recycled water, but lingering concerns about pathogens, emerging contaminants, or other potentially unknown contaminants warrant continued research to advance the science and technology in this area. Presently, California does not approve direct potable reuse projects, that is, where recycled water is piped directly from a treatment plant into a drinking water supply.

Recommendations

1. **Review Recycled Water Task Force recommendations.** The Recycled Water Task Force presented 26 recommendations to increase water recycling in its 2003 report, *Water Recycling 2030: Recommendations of California's Recycled Water Task Force*. Significant accomplishments have resulted from implementing the task force's recommendations. With the 10-year anniversary of the completion of the task force's efforts, DWR intends to review the recommendations and prioritize progress that should occur to complete the task force's mission.
2. **Develop approaches to facilitate increasing statewide use of recycled water for agricultural and environmental uses.** DWR, in cooperation with the SWRCB and the RWQCBs, will identify obstacles to increasing agricultural and environmental reuse of recycled water, with an emphasis on applications using secondary-treated wastewater. The focus of this effort is to implement "fit for purpose" and matching wastewater treatment levels to water quality requirements for the planned reuse to support meeting the State's 2020 and 2030 targets for recycled water use.
3. **Develop a uniform interpretation of State standards for recycled water.** State agencies including the SWRCB, the RWQCBs, the CDPH, DWR, and the CPUC should develop a uniform interpretation of State standards for inclusion in regulatory programs and IRWMPs and should clarify regulations pertaining to water recycling, including permitting procedures, health regulations and the impact on water quality. It is important to recognize that uniformity in State standards does not mean uniformity in permit terms and conditions, however, as implementation should account for the variability in local conditions and local needs. Implementing this recommendation could also streamline existing regulations about recycled water. Internal and cross-training of agency staff could be a key method of accomplishing this.
4. **Review National Research Council recommendations.** The National Research Council (2012) completed a comprehensive review of how recycled water use can be expanded. This report includes numerous recommendations, as well as possible approaches to implementing them. In 2013, DWR will take the lead in working with the other State agencies involved with recycled water to determine the applicability of the recommendations to California and to develop an approach to implementing these recommendations in California, as appropriate.
5. **Continue to review opportunities for recycled water development.** DWR will continue to identify opportunities to increase statewide planning, development, and implementation of recycled water. It is intended that this will be accomplished with comprehensive statewide planning documents and regional interactions over the next few years.
6. **Incorporate wastewater agencies into regional IRWM processes.** Inclusion of wastewater agencies into regional IRWM processes will facilitate the integration of recycled water into the

water supply planning process. In addition, potential recycled water customers should be involved in the IRWM and recycled water project planning process to identify potential partnerships, assess the viability of recycled water projects, and consider future CII water quantity and quality planning.

7. **Provide dedicated recycled water funding.** The State Legislature is urged to provide additional funding dedicated to planning and implementing recycled water projects in California. Although some funds are available through IRWM grants and loans, the cost of implementing these projects can make them difficult to put forth in the existing grant processes, especially with so many water suppliers facing financial challenges. If California intends to reach its water recycling mandates and goals and support future water supply reliability to support economic growth, then additional funds dedicated to recycled water implementation will need to be provided. Additional funding sources will be needed when Proposition 84 funds are no longer available.
8. **Develop reliable electronic reporting methods for recycled water data**. To be able to monitor progress in meeting targets or achieving progress in beneficially using recycled water, there is a need for reliable and periodic data collection. Voluntary surveys have been the historic method of data collection. Mandating standardized data collection integrated with electronic reporting could facilitate the collection of data and the availability of the data for use. DWR, the SWRCB, and the CDPH should work together to accomplish this objective.

Municipal Recycled Water in the Water Plan

[This is a new heading for Update 2013. If necessary, this section will discuss the ways the resource management strategy is treated in this chapter, in the regional reports and in the sustainability indicators. If the three mentions are not consistent, the reason for the conflict will be discussed (i.e., the regional reports are emphasizing a different aspect of the strategy). If the three mentions are consistent with each other (or if the strategy is not discussed in the rest of Update 2013), there is no need for this section to appear.]

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Table 12-1 Recycled Water Statewide [a] Goals and Mandates

Target type [b]	Target volume (in thousand acre-feet)					Notes	Source
	2000	2010	2015	2020	2030		
Potential		1,030			2,050	Midrange of projected potential use increases above 2002 levels	Recycled Water Task Force 2003
Goal	700	1,000					Water Recycling Act of 1991
Goal			1,250				State Water Resources Control Board 2008
Goal				1,525	2,525	1 million acre-feet above 2002 [c] for 2020 and 2 million acre-feet above 2002 for 2030	State Water Resources Control Board 2009b
Goal (draft)				1,000	1,300	Based on urban water management plans (UWMPs) and 2009 Municipal Wastewater Recycling Survey data	California Department of Water Resources 2013b
Mandate				869	1,169	200,000 acre-feet above 2009 for 2020 and an additional 300,000 acre-feet for 2030	State Water Resources Control Board 2009b

[a] The actual 2009 statewide volume of beneficially reused municipal recycled water was 669,000 acre-feet.

[b] Potentials, mandates, and goals are terms used in the identified sources. They are developed using various approaches. Mandates are stronger objectives, but in this case they do not carry a defined penalty for non-attainment.

[c] The Recycled Water Policy (State Water Resources Control Board 2009b) indicates that 2020 and 2030 goals are determined relative to the 2002 recycled water levels. The 2001 and 2002 numbers are considered the same because they were based on the same data.

Table 12-2 Regulatory Agency Roles and Responsibilities for the Regulation and Use of Municipal Recycled Water

Agency	Role	Responsibility	California Code of Regulations title number
California Department of Public Health	Protects public health	• Adopts uniform recycled water criteria for non-potable and potable recycled water projects [a] • Provides recommendations for recycled water project permits • Reviews and makes recommendations on sites proposed for recycled water use • Oversees cross-connection prevention [b] • Oversees protection of drinking water sources • Regulates public drinking water systems	Titles 17 and 22
State Water Resources Control Board	Protects water quality and water rights	• Establishes general policies governing recycled water project permitting • Oversees regional water quality control boards • Provides financial assistance to local agencies for recycled water projects • Allocates surface water rights	Title 23
Regional water quality control boards (nine)	Protects water quality	• Issue and enforce permits for recycled water projects, incorporating California Code of Regulations Title 22 requirements and California Department of Public Health recommendations • Protect surface water and groundwater quality from recycled water impacts	Title 23
California Department of Water Resources	Manages statewide water supply	• Evaluates use of and plans for potential future recycled water uses through the preparation of the California Water Plan • Provides financial assistance to local agencies for recycled water projects • Adopts standards for recycled water indoor plumbing	Title 24 (California Plumbing Code, Chapter 16A, Part II)
California Public Utilities Commission	Oversees rates and revenues of investor-owned utilities	• Approves rates and terms of service for the use of recycled water by investor-owned utilities	Title 20
California Department of Housing and Community Development	Oversees building standards for dwellings, including institutions and temporary lodgings	• Adopts standards for gray water systems in residential structures • Adopts standards for non-potable water systems within buildings over which it has jurisdiction	Title 24 (California Plumbing Code, Chapter 16A, Part I; Chapter 6)
California Building Standards Commission	Oversees adoption of standards for buildings	• Adopted standards for gray water systems in non-residential structures in 2011 cycle of California Building Standards Code • Oversees the adoption of the California Plumbing Code, including provisions added by other State agencies	Title 24 (California Building Standards)

Agency	Role	Responsibility	California Code of Regulations title number
Local building officials	Oversees building design, including plumbing	• Enforce building standards, including the California Plumbing Code	Title 24
County environmental health departments	Protects drinking water systems	• Enforce cross-connection control • Review and make recommendations on proposed recycled water use sites	Titles 17 and 22

[a] As of November 2011, the California Department of Public Health has adopted regulations in Title 22 for non-potable use of recycled water, but not for potable reuse projects. Senate Bill 918 requires the department to adopt uniform water recycling criteria for indirect potable reuse projects involving groundwater recharge and surface water augmentation.

[b] The California Department of Public Health may delegate some responsibilities for review of new sites and cross-connection control to the local county health departments with the permission of the local recycled water provider.

Table 12-3 Important Recycled Water Policies and Regulations

Year	Action	Organization	Summary
1984	Water Quality Order 84-7	State Water Resources Control Board	Pursuant to California Water Code, Section 13142.5(e), in cases where discharges of wastewater to the ocean are proposed in “water-short” areas, the report of waste discharge should include an explanation as to why the effluent is not being recycled for further beneficial use.
2001	Assembly Bill 331, Recycled Water Task Force	California Assembly	This bill established a 40-member Recycled Water Task Force to evaluate the current framework of State and local rules, regulations, ordinances, and permits to identify the opportunities for, and obstacles or disincentives to, increasing the safe use of recycled water. The task force was composed of individuals representing federal, State, and local government; public health professionals; private sector entities; environmental organizations; the University of California; internationally recognized researchers; and public interest groups. The task force was a cooperative effort of DWR, the State Water Resources Control Board, and the California Department of Health Services (now the California Department of Public Health).
2003	Recycled Water Task Force	California Department of Water Resources	The Recycled Water Task Force presented its findings and recommendations in a final report titled *Water Recycling 2030: Recommendations of California’s Recycled Water Task Force*. The task force estimated the future potential and costs of water recycling and made a wide variety of findings, many of which are reflected in this chapter. The task force issued 26 recommendations to increase water recycling. The recommendations are broad, are not limited to legislative actions or statutory changes, and as of this update are still worthy recommendations in need of being fully implemented. Work has been accomplished on many of the recommendations.
2003	Assembly Bill 334, Water Softening and Conditioning Appliances	California Assembly	This bill authorized local agencies to adopt regulations governing water softeners or conditioning appliances that discharge salt into the community sewer system. The Water Softening and Conditioning Appliances bill specifically authorizes local agencies, by ordinance, to limit the availability or use, or prohibit the installation, of water softening or conditioning appliances that discharge to the community sewer system.
2004	*Incidental Runoff of Recycled Water* memorandum	State Water Resources Control Board	This memorandum reviewed the legal requirements of federal and State statutes and regulations that relate to the regulation of incidental runoff and, to determine the available regulatory and enforcement options, conducted legal analysis and conducted stakeholder meeting to arrive at the decisions in the memorandum.
2006	Uniform Analytical Method for Economic Analysis framework	State Water Resources Control Board	This was a partially funded research project to develop a Uniform Analytical Method for Economic Analysis framework for evaluating the benefits and costs of water reuse by the WateReuse Foundation (August 2006). The State Water Resources Control Board convened the Economic Analysis Task Force with participation from State, federal and university members in fall 2008.

Year	Action	Organization	Summary
2006	Climate Action Team, created in response to Assembly Bill 32	California Environmental Protection Agency	The Climate Action Team was created to formulate measures to mitigate the effects of climate change. Water recycling can contribute to the reduction of greenhouse gas emissions by replacing energy-intensive imported water with local recycled water. To that end, the Climate Action Team formulated a water recycling measure to require the development and implementation of wastewater recycling plans. The water recycling CAT measure is identified in *Climate Change Scoping Plan: A Framework for Change* prepared by the California Air Resources Board in 2008.
2007	Assembly Bill 1481, Landscape Irrigation	California Assembly	This bill required the regional water quality control boards to prescribe general waste discharge requirements (a general permit) for landscape irrigation that uses recycled water for which the California Department of Public Health has established uniform statewide recycling criteria. The State Water Resources Control Board adopted the General Permit for Landscape Irrigation of Municipal Recycled Water, which further supports the use of recycled water in California while protecting the water quality.
2009	Recycled Water Policy	State Water Resources Control Board	This action was for implementing state statutes, regulations, and policies for recycled water projects to establish more uniform interpretation (State Water Resources Control Board 2009a, 2009b). This policy aims to increase the use of recycled water from municipal wastewater sources (as defined in California Water Code Section 13050(n)), in a manner that implements State and federal water quality laws.
2009	California Plumbing Code	California Department of Water Resources	This action addressed plumbing within buildings with both potable and recycled water systems. The California version of these provisions was adopted in 2009 and became effective in 2010. This section of the plumbing code will provide guidance throughout the state to safely plumb buildings for indoor use of recycled water for toilet and urinal flushing.
2009	Recycled water symbol change in code	California Department of Housing and Community Development	The department adopted a recycled water symbol change to remove the requirement for the skull-and-crossbones symbol in sections 601.2.2 and 601.2.3 of the California Plumbing Code. Now the symbol is a picture of a glass containing liquid, encircled, and with a line slashed through, indicating the liquid should not be ingested.

Figure 12-1 Municipal Recycled Water Affiliations with Other Resource Management Strategies

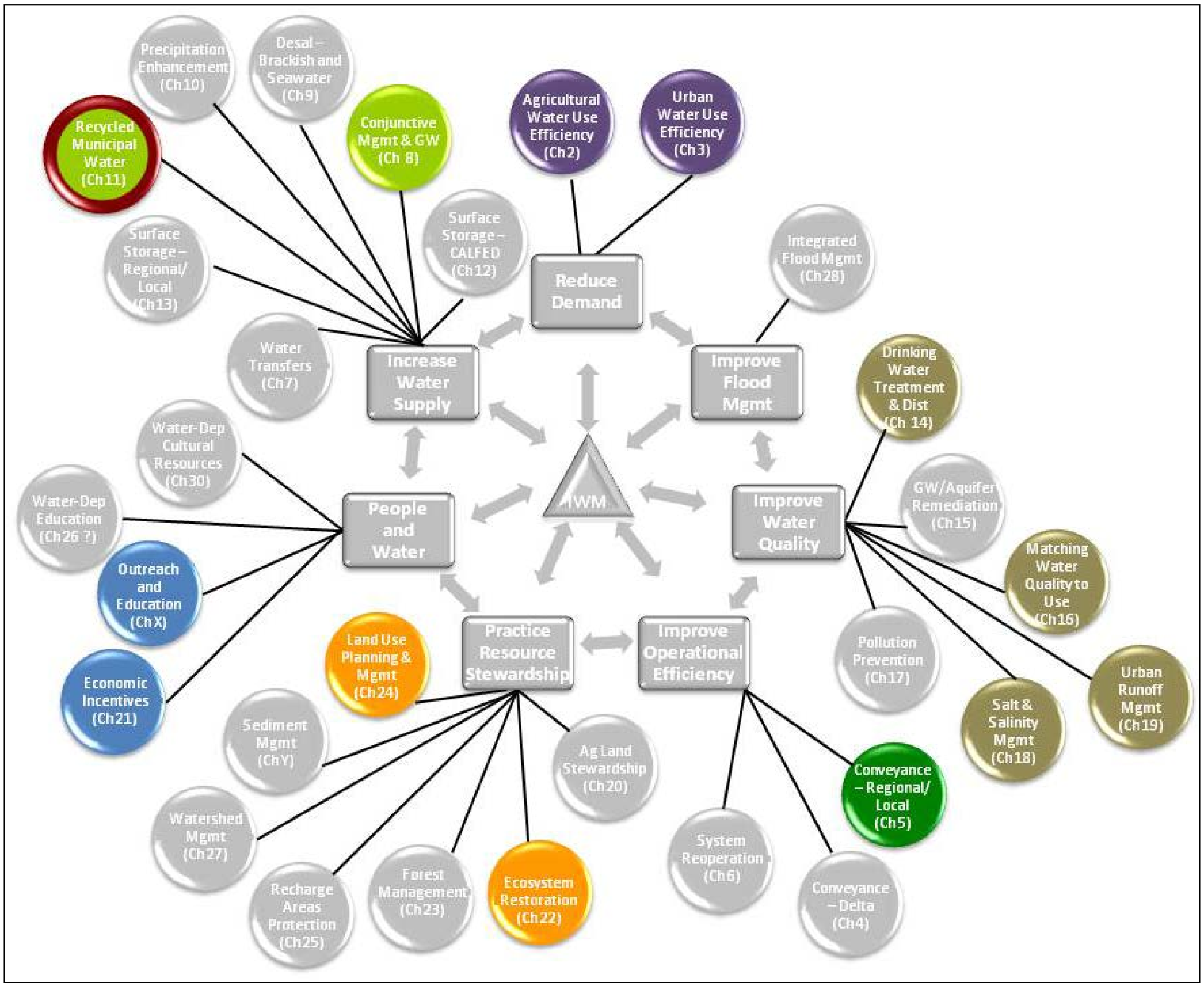


Figure 12-2 Municipal Recycled Water Cycle

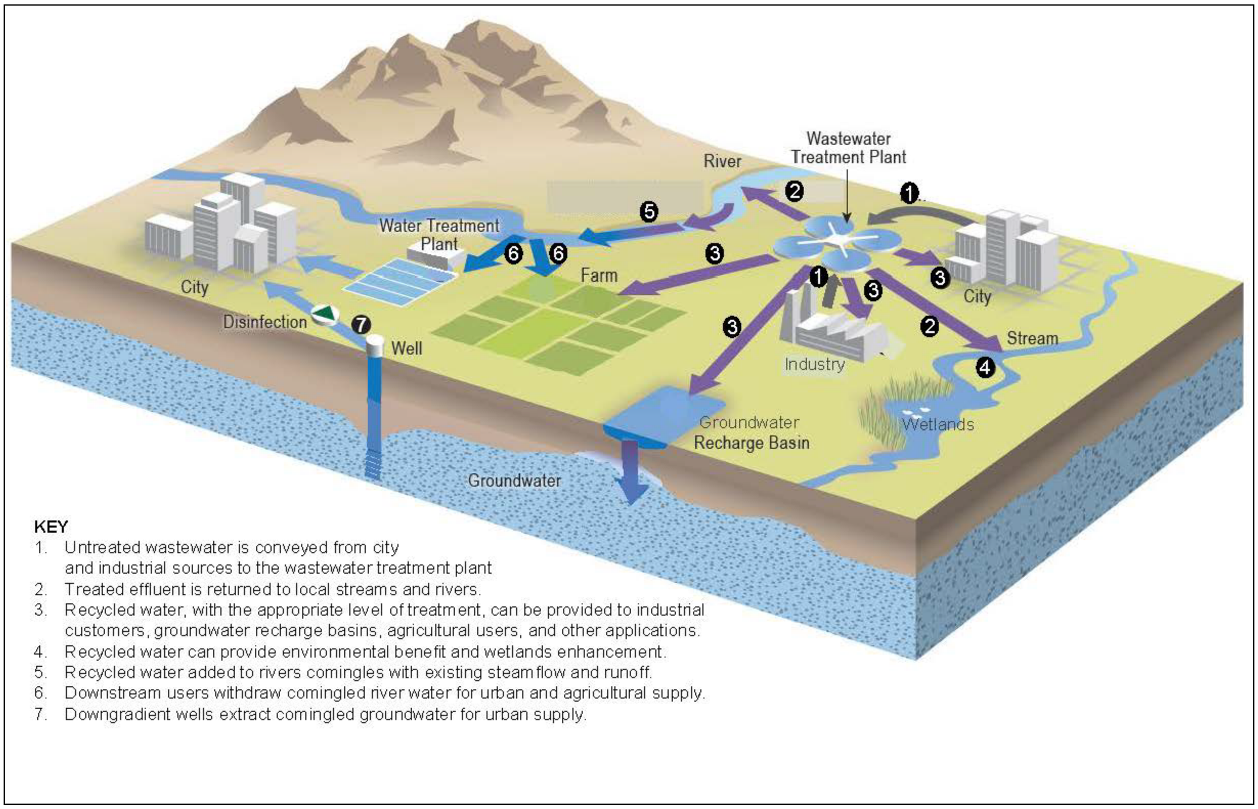


Figure 12-3 Potable and Non-Potable Municipal Recycled Water

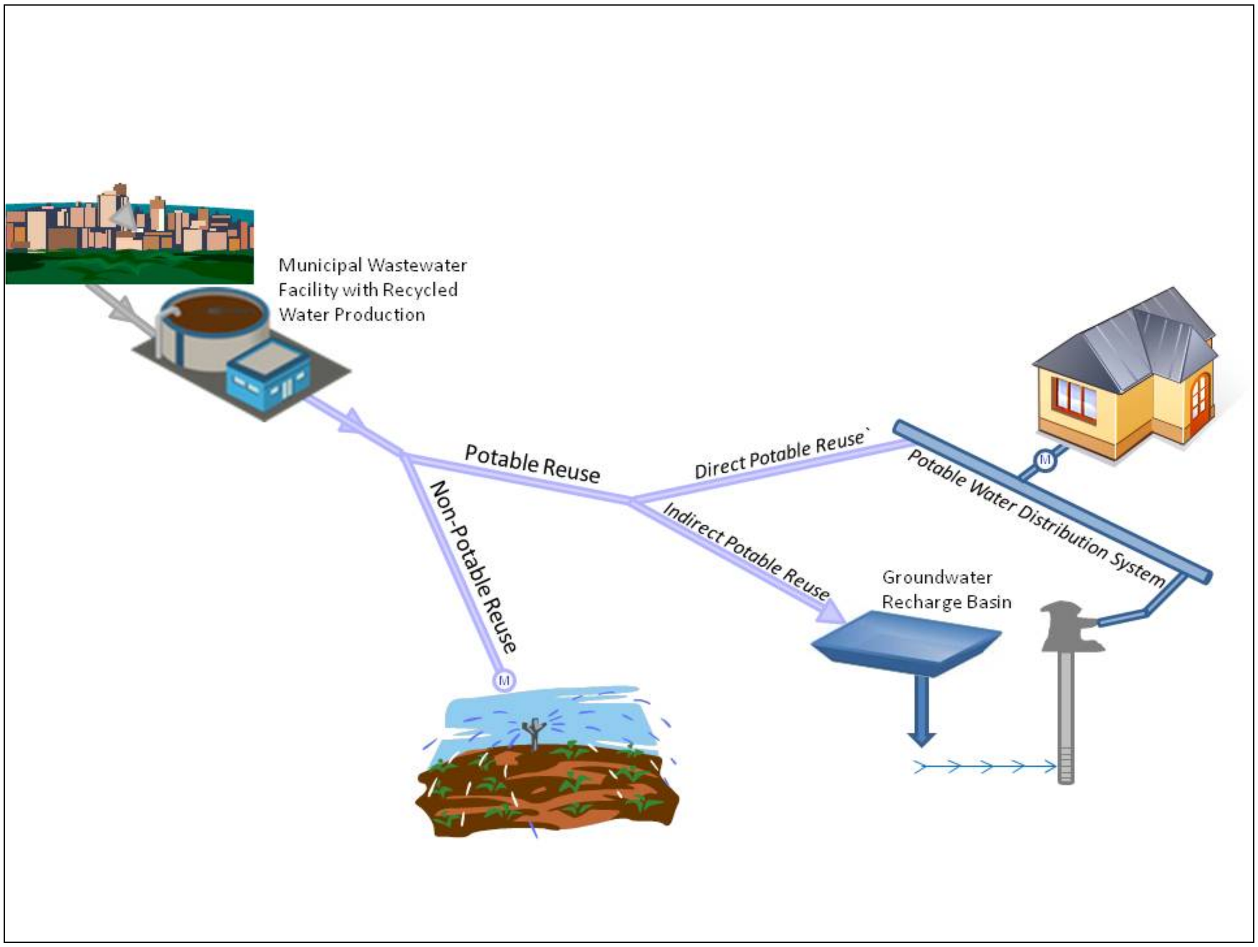


Figure 12-4 Municipal Recycled Water Use in California Since 1970

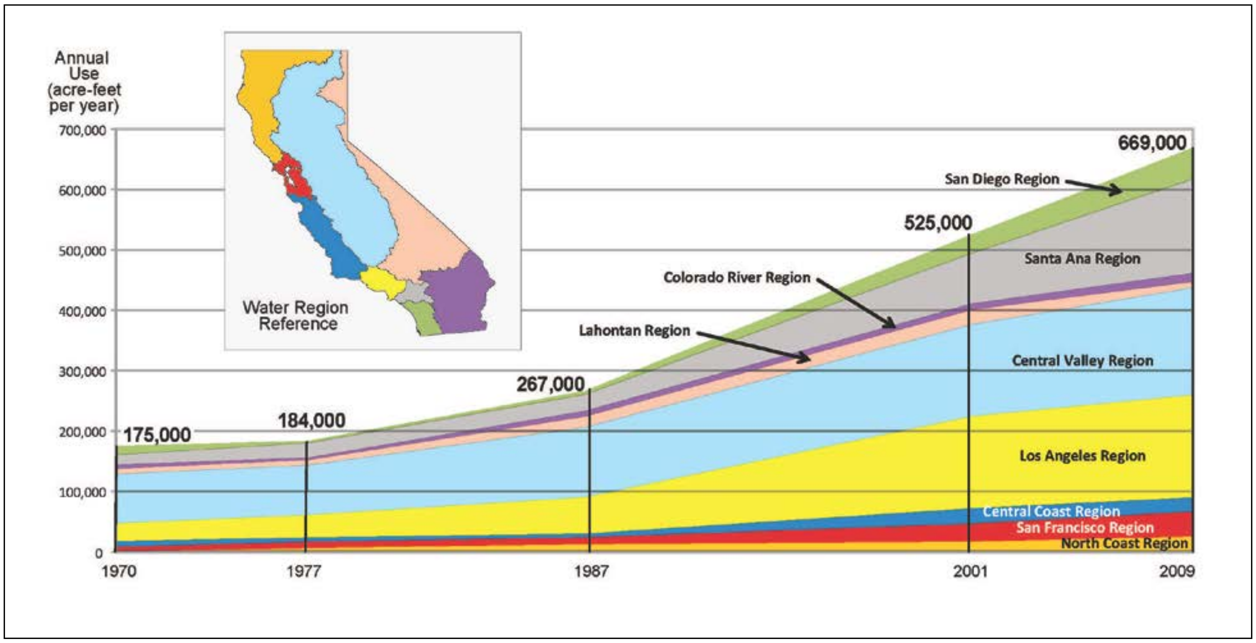


Figure 12-5 Changes in California's Recycled Water Beneficial Uses

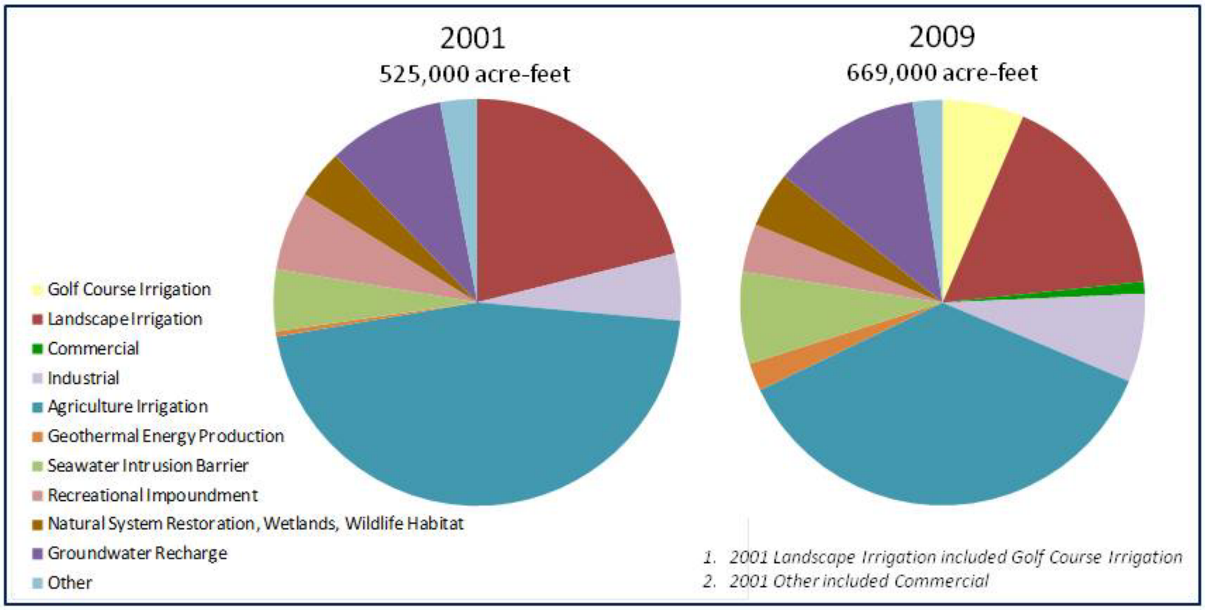


Figure 12-6 Municipal Recycled Water Use by County in 2009

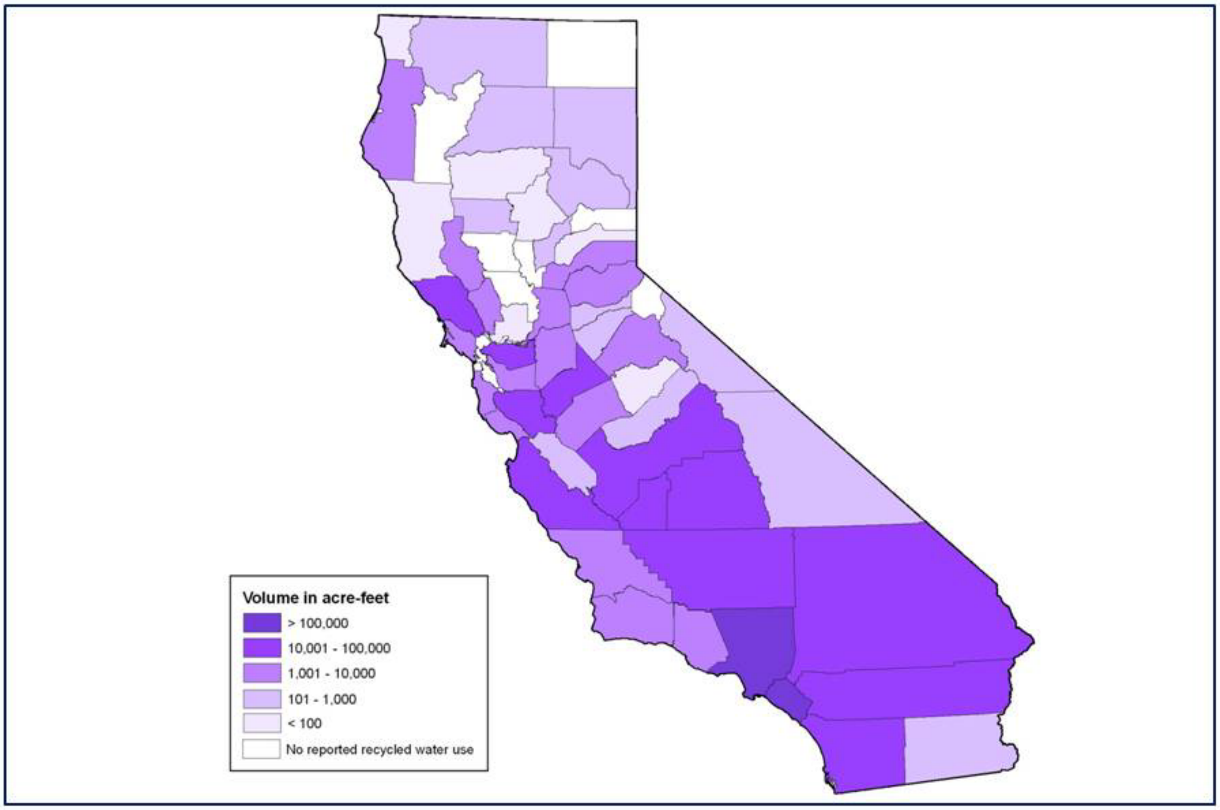
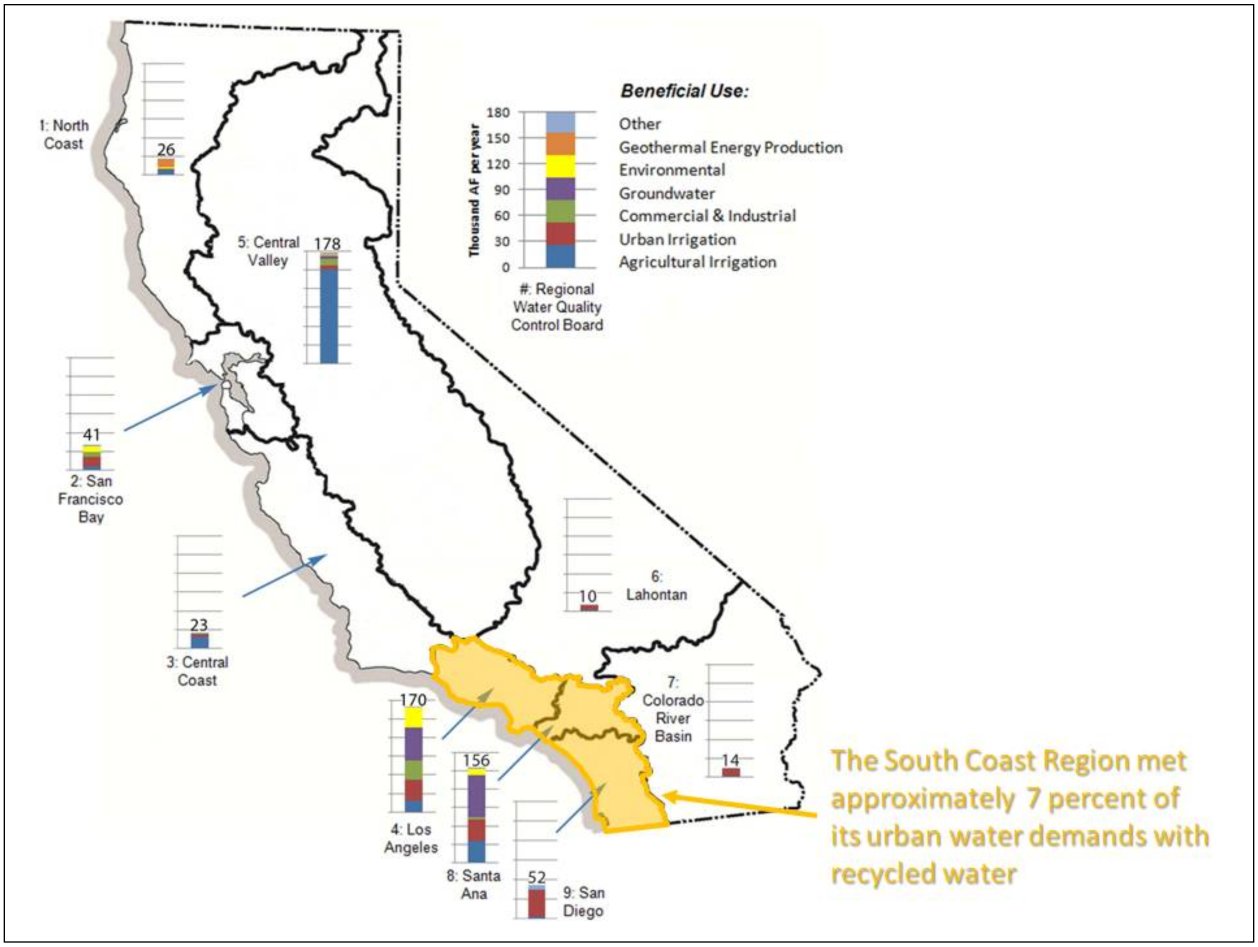


Figure 12-7 Regional Variations in Beneficial Uses of Municipal Recycled Water in 2009



Chapter 3. Urban Water Use Efficiency — Table of Contents

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Chapter 3. Urban Water Use Efficiency

Over the past few decades, Californians have made great progress in urban water use efficiency. Once viewed and invoked primarily as a temporary strategy in response to a drought or emergency water shortage situation, water use efficiency has become a permanent part of the long-term management of California's water supply. At the individual level, the benefits of water use efficiency may appear small, incremental, or difficult to see, but when Californians act together as a community to conserve water, the cumulative effect is significant, and the benefits are widespread.

There are several factors that have contributed to increased water use efficiency: outreach efforts that have increased awareness and changed behaviors; urban water suppliers' implementation of best management practices (BMPs); plumbing codes requiring more efficient fixtures; the Model Water Efficient Landscape Ordinance (MWELO); new technologies in the commercial, institutional, and industrial (CII) sectors; and mandates requiring that unmetered connections become metered.

However, with tighter environmental constraints on the Sacramento-San Joaquin River Delta (Delta), increasing population, and the necessity of adapting to climate change, even greater efficiencies will be needed and are achievable. When faced with an increasing demand for water, water agencies can consider options for increasing supplies or reducing demand, or a combination of both, to meet this need. Increasing water supply can be expensive and can include costs of purchasing additional water, capital cost of production and distribution systems, water supply treatment facilities, energy costs, and wastewater treatment facilities. Reducing demand through increased water use efficiency is generally lower cost and quicker to implement.

In an effort to emphasize and increase water use efficiency, the State Legislature has directed urban retail water suppliers to reduce urban per-capita water use by 20 percent by the year 2020. This legislation, the Water Conservation Act of 2009 (Senate Bill [SB] No. 7 of the 7th Extraordinary Session, or SB X7-7), was enacted as part of a five-bill package aimed at improving the reliability of California's water supply and restoring the ecological health of the Delta. SB X7-7 had multiple urban and agricultural water use efficiency provisions. The key urban conservation measure established a statewide goal of reducing urban per-capita water use by 20 percent by 2020. Meeting this statewide goal of a 20- percent decrease in demand will result in nearly a 2 million acre-foot (maf) reduction in urban water use in 2020.

This chapter will present the practices already employed in urban water conservation, as well as describing how further efficiencies can be achieved and how the goal of 20-percent reduction by 2020 can be met.

Urban Water Use Efficiency Today in California

Demand Management Measures and Best Management Practices

Demand management measures (DMMs) and best management practices (BMPs) are practices that can be used by urban water suppliers to conserve water, and the implementation of these practices has been a major driving force behind urban water conservation in California.

The Urban Water Management Planning Act placed the DMMs in the California Water Code (Sections 10610-10656) and required urban water suppliers serving more than 3,000 connections or more than 3,000 acre-feet (af) of water per year to describe their DMM implementation in their urban water management plans (UWMPs), which are required to be updated and submitted to the California Department of Water Resources (DWR) every five years.

These DMMs were included in the California Urban Water Conservation Council's (CUWCC's) memorandum of understanding (MOU). The CUWCC was created to increase efficient water use statewide through partnerships among urban water agencies, public interest organizations, and private entities. The council's goal is to integrate DMMs into the planning and management of California's water resources. When the DMMs were incorporated into the MOU, they were labeled as BMPs. Water agencies that became signatories to the MOU pledged to implement the BMPs to specified levels and to report progress on their BMP implementation biannually to the CUWCC.

Originally, the CUWCC BMPs were the same as the DMMs listed in the Urban Water Management Planning Act. But in 2008, the CUWCC BMPs underwent a significant revision. The BMPs were reorganized as either "Foundational" or "Programmatic" BMPs and were renumbered, as is reflected in Table 3-1. More details on the revised BMPs can be found at http://www.cuwcc.org.

The CUWCC BMP revision also provided member agencies three options for complying with the BMP water saving goals. The goals could be met through one of the following three measures:

- Performing the specific measures listed in each BMP.
- Performing a set of measures that achieves equal or greater water savings, referred to as the Flex Track Menu.
- Accomplishing set water savings goals as measured in gallons per capita per day (gpcd) consumption.

In order to be eligible for grant or loan funding from the State of California, an urban water supplier, whether a signatory to the CUWCC MOU or not, must demonstrate that its efforts in implementing each DMM or BMP will be implemented at the coverage level determined by the CUWCC MOU.

Some of the BMPs provide quantifiable water savings, and others do not. For example, within BMP 3 is the practice of toilet retrofits; replacing a 5-gallon-per-flush toilet with a 1.6-gallon-per-flush toilet yields water savings of 3.4 gallons per flush. Contrast that with BMP 2, "Education and Information Programs." Although education is critical to conservation and necessary to move people to new behaviors, it is not possible to correlate each educational effort with specific water savings.

PLACEHOLDER Table 3-1 Best Management Practices

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

20 x 2020: A New Direction

Box 3-1 describes the history, process, and impact of the *20x2020 Water Conservation Plan* (20x2020 Plan).

PLACEHOLDER Box 3-1 20x2020 Plan: History, Process, and Impact

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Baseline Water Use

The period used for baseline water use is roughly 1996 to 2005, though suppliers could choose any 10 consecutive years from between 1995 and 2010.

After compiling baseline water use from 342 water agencies, the statewide average baseline water use was calculated to be 198 gpcd (California Department of Water Resources 2012b).

Figure 3-1 shows how baseline water use differs regionally across the state, and Figure 3-2 displays the range of per-capita water use reported by the water agencies in their 2010 urban water management plans (UWMPs). Generally, lower water use is seen along the coast, with increasing water use in the inland valleys; however, low or high per-capita water use is not necessarily an indicator of efficiency. Climate and land use factors can have a significant effect on water use. The coastal areas generally use less water in their landscapes because the marine climate provides a lower rate of evapotranspiration and because the sizes of coastal residential landscapes tend to be smaller than those of inland areas. Increased efficiencies have also been needed on the coast, because these communities were strongly affected by the 1988-1992 drought and a number of conservation programs were implemented to improve water supply reliability.

PLACEHOLDER Figure 3-1 Average Baseline Water Use by Hydrologic Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

PLACEHOLDER Figure 3-2 Range of Reported Baseline Water Use

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Baseline Water Use by Sector

The total volume of urban water use, statewide, as reported in *California Water Plan Update 2009* (Update 2009) is 8.8 million acre feet (maf) per year (California Department of Water Resources 2009). This is an eight-year average for the time period of 1998-2005. There is some variation in water use reporting between Update 2009 and the 20x2020 calculations used in UWMPs. When estimating urban water use, Update 2009 calculations included the use of recycled water, self-supplied industrial water, potable water supplied to agriculture, conveyance losses, and water used for groundwater recharge. The 20x2020 calculations used in UWMPs do not include these urban water uses.

Table 3-2 and Figure 3-3 show the division of the 8.8 maf of urban water use (California Department of Water Resources 2009) into water use sectors.

PLACEHOLDER Table 3-2 Statewide Urban Water Uses

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

PLACEHOLDER Figure 3-3 Statewide Urban Water Use — Eight-Year Average 1998-2005

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Water Use in 2010 — Progress in Achieving 20-Percent Reduction by 2020

The 2010 statewide average water use, as reported in 2010 UWMPs, was xxxx [still being calculated].

Because of the economic downturn, the 2007-2009 drought, and a cool summer in 2010, many suppliers have reported significant drops in water use in the last few years, and some have already met their 2020 water use target. These suppliers are now focused on ways to keep water use low once the economy improves and a more typical weather pattern returns.

2015 and 2020 Water Use Targets

Water suppliers reported their 2015 and 2020 per-capita water use targets in their 2010 UWMPs. The average 2020 target reported was 166 gpcd. This target is a 16-percent reduction from the statewide average baseline of 198 gpcd, which is less than the 20-percent goal. The legislation provided four methods for calculating the 2020 target, and this allowed some suppliers to select targets lower than the 20-percent goal, but none of the methods require suppliers to select targets higher than 20 percent.

After receiving the 2015 UWMPs, DWR is required to report to the Legislature on progress toward the 20-percent reduction goal. Suppliers are expected to be halfway between the baseline and the 2020 target by 2015. If the state, overall, is not on track to meet the 20-percent target, DWR is directed to provide recommendations to the Legislature on how the goal can be achieved.

A list of the individual water supplier's baselines and targets and more information on statewide and hydrologic region averages is available in DWR's report to the Legislature on the 2010 UWMPs (California Department of Water Resources 2012b).

PLACEHOLDER Box 3-2 Demand Hardening

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Meeting the Targets — Potential Savings by Sector

Since the early 1990s, voluntary implementation of BMPs and new codes and regulations have increased water use efficiency in California. However, abundant opportunities still exist to increase urban water use efficiency, and many of these opportunities will need to be tapped in order for California to achieve its 20-percent reduction goal by 2020.

Descriptions of the potential for increased savings are presented below. These represent a statewide overview and are not intended as a blueprint for individual water agencies, because each agency will have its own unique strategy for achieving the 20-percent reduction.

All water savings noted in the following sections are comparisons to the baseline water use reported by water suppliers in their 2010 UWMPs. Because baselines and targets are reported in gpcd, the descriptions presented below will state the current water use and potential savings in gpcd.

Landscape Irrigation

Annual water demand for residential and large landscape irrigation amounts to approximately 4 maf, or about 45 percent, of urban demand. Because this sector represents such a large portion of urban water demand and because water waste from landscapes is common — water running down street gutters, leaks, watering during rainstorms, etc. — landscape irrigation presents the greatest opportunity for increasing efficiency and reducing unnecessary demand.

PLACEHOLDER Box 3-3 Landscape Irrigation Runoff

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Increased landscape water use efficiency can be accomplished with a variety of tools that are effective in any landscape sector, whether residential, commercial, or institutional. Some of these tools include regular maintenance of irrigation systems, irrigation audits to identify deficiencies, development of landscape water budgets, and selection of low-water-using plants. Some tools are low- or no-cost and can provide immediate and significant savings.

Urban landscapes can be divided into three categories: residential; large landscape; and commercial, institutional, and industrial (CII) mixed meter. Each of these uses is addressed more specifically below.

PLACEHOLDER Box 3-4 The Value of Landscape Water Budgets

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Residential Landscapes

Residential landscape irrigation represents the single largest end use of urban water, accounting for 35 percent of total urban use (California Department of Water Resources 2009).

Many factors contribute to the large amount of water used in residential landscapes, including population shifts to hotter interior regions, which often have larger residential landscapes (Hanak and Davis 2006); the prevalence of cool-season turf grasses and other high-water-use plants; irrigation systems that are inefficient and poorly maintained; and widespread overwatering of all plant types.

When comparing homeowners’ actual landscape water use to a theoretical water requirement, one sees a mix of irrigation behaviors: homeowners who under-irrigate and those who over-irrigate (Irvine Ranch Water District 2011). It can be assumed that most of those who under-irrigate are nevertheless satisfied with the quality and appearance of their landscapes; otherwise, those homeowners would have increased their water use.

There are at least two possible explanations for this phenomenon: Either some landscapes require less water than previously thought, because actual plant water needs, soil conditions, and cultural factors contribute to a lower demand, or the standard used to estimate the theoretical water requirements needs to be reevaluated. It is apparent that many landscapes are successfully irrigated at rates below the current theoretical requirement.

Prior to 2010, landscapes that were installed in compliance with the Model Water Efficient Landscape Ordinance (MWELO) (California Code of Regulations Title 23, Division 2, Chapter 2.7, Section 490) were allowed a water budget that did not exceed an evapotranspiration adjustment factor (ETAF) of 0.8. (For more explanation on the ETAF, see the reference for California Department of Water Resources 2008, listed at the end of this chapter under the “References Cited” heading.) When the MWELO was updated in 2010, the water budgets for most landscapes were reduced so that they may not exceed an ETAF of 0.7. The Landscape Task Force recommended that the ETAF be reviewed every 10 years for possible further reduction (California Urban Water Conservation Council 2005b). After more research is completed in plant water needs, it may be appropriate to lower the ETAF used in the water budget calculation.

In light of these findings, water suppliers would benefit from targeting their most resource-intensive landscape conservation efforts to water users that are over-irrigating (Irvine Ranch Water District 2011). As a marketing tool, a cost-benefit analysis based on water rates and other factors can help determine which customers would be the best candidates for intervention, both in terms of maximizing water supplier resources and customer buy-in. Furthermore, because most residential users underestimate the quantity of water used in their landscape (California Urban Water Conservation Council 2007c), education components remain a vital tool in that they increase the water savings potential.

Several water use studies (Pacific Institute 2003; Irvine Ranch Water District 2001; Hanak and Davis 2006; Irvine Ranch Water District 2011) indicate that residential landscape water demand can potentially be reduced by at least 20 percent, with some researchers estimating savings potential of 45 percent or more (Pacific Institute 2003).

The statewide average baseline water use for residential landscape irrigation is estimated at 81 gpcd (from a total baseline water use of 198 gpcd). This is derived as follows: Baseline residential outdoor use is 3.0 maf (see Table 3-2), divided by a 2000 population of 33,780,000, and then converted to gpcd.

A conservative estimate of 20-percent reduction in residential landscape water use would represent a savings of 16.2 gpcd, equating to an annual statewide reduction of 0.79 maf by 2020.

Large Landscapes (Dedicated Meters)

Large landscapes are commercial, industrial, and institutional (CII) landscapes that are a category set apart by the presence of dedicated irrigation meters. Dedicated metering serves the purpose of accurately measuring the water use of a landscape and making it possible to assign and monitor water budgets and detect leaks. The CUWCC landscape BMP (formerly BMP 5) requires water use budgets to be assigned at 70 percent of local reference evapotranspiration (ETo).

Based on an eight-year average of DWR data (see Table 3-1 and Figure 3-3), large landscapes with dedicated meters accounted for 10 percent of urban water use or 0.8 maf. Water use through a dedicated landscape meter can be monitored by the irrigator and can provide immediate feedback on the amount of water moving through the meter. Programs such as the California Landscape Contractors Association (CLCA) Water Management Certification Program (WMCP) (California Landscape Contractors

Association 2012) enable irrigation managers to monitor and track water use and manage a landscape at 80 percent of ETo or less.

PLACEHOLDER Box 3-5 Dedicated Water Meters: California Water Code Section 535

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

The numbers and total acreage of sites designated as large landscapes will increase over time as mixed-use meters at existing CII landscapes are retrofitted to dedicated meters. All new CII landscapes over 5,000 square feet require a dedicated irrigation meter and are more accurately known as “large landscapes.”

A CII landscape water use efficiency study (California Landscape Contractors Association 2003) collected data from 449 CII landscapes. The results indicate that approximately 50 percent of CII landscapes were irrigated in excess of 100 percent ETo. If those sites reduced water use to maintain a water budget of 100 percent ETo, the author estimates a 15-percent demand reduction could be achieved. Potential landscape efficiency gains could be much greater than 15 percent if conversions from cool-season turf to water efficient plants were included and if the water budget were reduced to seventy or eighty percent of ETo.

Recent WMCP information from the CLCA Water Forums indicates that many sites maintained and managed under the WMCP are performing at water budgets of 80 percent of ETo or less, with average irrigation rates of 64 percent of ETo for the 704 sites enrolled in the WMCP in 2012 (California Landscape Contractors Association 2012).

However, some water suppliers have found that after assigning water budgets and conducting outreach efforts, they are still not seeing the savings estimated in the 2003 CLCA CII landscape study, nor do they believe potential for further savings is as great (Brown pers. comm. Oct. 26, 2012). Other suppliers have seen a drop in landscape water use but attribute these savings not only to the training programs, but also to pricing, shortages, and other factors as well (Granger pers. comm. Oct. 19, 2012).

Newer study results will give a more current picture of CII landscape water use efficiency, but it is clear that sites that are actively managed by trained personnel are generally the most efficient and still retain potential for further savings.

Statewide average baseline water use for large landscapes is estimated at 21 gpcd. Using a conservative estimate of a 15-percent reduction (3 gpcd), annual demand reduction by the year 2020 would be approximately 0.15 maf.

Commercial, Industrial, and Institutional Landscapes (Mixed-Use Meters)

Opportunities for water savings in CII landscapes with mixed-use meters are probably as high as residential landscapes; however, significant data gaps exist due to inconsistencies in water use reporting. Suppliers voluntarily report their public water supply production and, depending on the agency, landscape water use may be included in CII, multi-family, or “other” categories. Because of these data gaps, potential water savings in CII landscapes with mixed-use meters cannot be separated from CII water use and are included as part of CII water savings, discussed later in this chapter.

Indoor Residential Water Use

Indoor residential water use (both single and multifamily housing) accounts for about 31 percent of total urban water use in California (See Figure 3-3 and Table 3-2). This equates to a statewide average baseline water use for indoor residential of 62 gpcd. This is derived by using 8.8 maf for the total annual urban water use (California Department of Water Resources 2009) and 33,780,000 for the 2000 population.

A comparison of California's baseline indoor residential water use, 62 gpcd, to a study of homes retrofitted with WaterSense and Energy Star fixtures and appliances (U.S. Environmental Protection Agency 2008), which had water use of 43 gpcd, shows that significant savings remain to be captured in this sector.

Residential indoor water is delivered through only a small number of fixtures — toilets, clothes washers, showers, faucets, and dishwashers. The percentage of water use by fixture is displayed in Figure 3-4. The following paragraphs address these fixtures, and potential savings, in more detail. Several regulations mandate high-efficiency fixtures. A discussion and comparison of these regulations is provided by the California Urban Water Conservation Council (2010).

PLACEHOLDER Figure 3-4 Estimated Indoor Residential Water Use in California (Year 2000)

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Toilets

A study by American Water Works Association (AWWA) Research Foundation (1997) revealed that toilets were the biggest component of indoor water use at that time. Many older, inefficient toilets have been replaced with more efficient models since then, but, years later, it appears that toilets are still the largest user of indoor residential water use. More current studies (Pacific Institute 2003; Irvine Ranch Water District 2011) show that toilets account for 20 percent to 33 percent of indoor water use, which equates to an average of 13-19 gpcd.

Older toilets use 3.5 or 5 gallons per flush (gpf), but regulations have mandated increased efficiency. The 1992 California code required that new toilets sold in the marketplace have a flush volume of 1.6 gpf. These are called ultra low-flow toilets (ULFTs). In 2014 the code will require an even greater efficiency of 1.28 gpf. These toilets are known as high-efficiency toilets (HETs) and have been mandated in new construction since 2011.

Many existing toilets remain to be converted to efficient models. Estimates are that the saturation of ULFTs and HETs is 54 percent to 60 percent. (Irvine Ranch Water District 2011; 20x2020 Agency Team on Water Conservation 2010).

The 20x2020 Plan calculates that retrofitting residential toilets, so that 81 percent are ULFT or HET, could save roughly 5 gpcd.

Clothes Washers

Clothes washers account for 14 percent to 18 percent of indoor residential water use (Pacific Institute 2003; Irvine Ranch Water District 2011), which is about 9-10.5 gpcd. However, according to the

California Single Family Home Water Use Efficiency Study (Irvine Ranch Water District 2011), only about 20 percent of homes studied in 2007 were using efficient washers. This indicates that there is great potential for decreasing per-capita water use for clothes washing through appliance replacement.

The water efficiency of clothes washers is rated using the term “water factor.” The water factor is measured by the quantity of water (gallons) used to wash each cubic foot of laundry. The lower the water factor rating, the more water-efficient the clothes washer.

Standards for the water efficiency of residential clothes washers have been put in place by the U.S. Department of Energy. These water factor standards have been moving progressively lower over several years. The most current standard will culminate in 2018 with a maximum water factor of 6.0 for standard top-loading machines and a maximum water factor of 4.5 for standard front-loading machines. For comparison, conventional washers have a water factor of 12 to 13.

The 20x2020 Plan estimated that potential savings from efficiency codes, active rebate programs, and natural turnover of clothes washers would equal 4-6 gpcd.

Leaks

Studies from Pacific Institute (2003) and Irvine Ranch Water District (2011) reveal that the water lost to leakage in the residential sector averages from 7 to 10 gpcd. This number is relatively large; however, the majority of the water loss was concentrated in a small number of homes. The median loss was found to be small, between 1.4 and 3.9 gpcd. Yet, 14 percent of the homes lost more than 17 gpcd to leaks, and 7 percent of the homes were leaking more than 34 gpcd. This variability suggests that leak reduction programs that target the homes with the highest leakage rates would be the most cost-effective for a water supplier.

Water suppliers can employ several methods to detect homes with high rates of leakage, including:

- Developing water budgets. Homes with leaks will exceed their water budgets and pay excess use rates, thus encouraging repair.
- Installing advanced metering infrastructure (AMI). AMI monitors water usage in real time, sampling hourly to every 15 minutes. Because of the frequent monitoring and collection of water use data, a constant flow (leak) can be detected quickly and efficiently.
- Identifying excessive water users (by comparison of water bills with similar properties) and offering water audits to these customers.

PLACEHOLDER Box 3-6 Case Study: City of Sacramento Advanced Metering Infrastructure

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

If leaks were to be detected and repaired at homes with high leak rates, so that the average losses due to leaks were reduced to the median values (1.4-3.9 gpcd), the savings would be 6-7.5 gpcd (Pacific Institute 2003; Irvine Ranch Water District 2011).

Conservatively estimating that, on a statewide average, water agencies were able to work with their residential customers so that just less than half of this potential leakage could be detected and repaired, the savings would then be 3 gpcd.

Showers

Showers account for about 21 percent of indoor residential use, equivalent to about 11.8-13.5 gpcd.

A study by Irvine Ranch Water District (2011) found that nearly 80 percent of all homes had showerheads operating at 2.5 gallons per minute (gpm) or less (the federal standard, as specified by the Energy Policy Act of 1992). WaterSense-rated showerheads have a maximum flow rate of 2.0 gpm or less, producing even greater savings. Further savings in shower water use can be achieved by continued retrofitting of inefficient shower heads and public education campaigns that include messages to take shorter showers.

The 20x2020 Plan estimates that the potential water savings remaining to be captured in shower water use are roughly 1 gpcd.

Faucets

Faucets account for about 19 percent of indoor use, approximately 11-12 gpcd.

The maximum flow rate for new faucets, set by federal standards in 1994, is 2.5 gpm, though some faucets, especially bathroom faucets, can operate as low as 0.5 gpm. The 1997 AWWA Research Foundation study estimated a 50-percent penetration of 2.2 gpm faucet aerators.

Savings in faucet water use can be achieved by continued retrofitting with low-flow fixtures and aerators and public education campaigns that include messages to "turn off the tap" when water is simply going down the drain.

The *California Single Family Home Water Use Efficiency Study* (Irvine Ranch Water District 2011) assumes a reduction of 10 percent in faucet water use (11.5 gpcd X 10 percent = 1 gpcd). This equates to a savings of 1 gpcd.

PLACEHOLDER Box 3-7 Multi-Family Dwellings and Sub-Metering

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Total Projected Savings for Indoor Residential

Adding the savings from each of the fixtures and appliances above, total projected water savings for indoor residential use is 15 gpcd (Table 3-3).

PLACEHOLDER Table 3-3 Potential Savings for Indoor Residential Water Use

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Commercial, Industrial, and Institutional Sectors

The CII sectors cover a broad range of water uses, from schoolyard playgrounds and drinking faucets to bottling plants and restaurants. It is, therefore, a challenge to address these sectors, whether trying to make broad generalizations about CII water use as a whole or trying to drill down and find detailed data on any particular use. The State does not currently have the data necessary to establish the baseline of use in each CII subsector, and the information needed to estimate statewide savings must await the development of baselines and metrics.

The CII sectors (not including large landscapes) use about 20 percent of urban water, which equates to 1.7 maf per year, or approximately 48 gpcd (California Department of Water Resources 2009, 2012a; Pacific Institute 2003; 20x2020 Agency Team on Water Conservation 2010).

If water used for large landscapes is added to CII water use, the total CII water use would then be approximately 30 percent of urban water use. The 30-percent figure is often quoted for CII water use. However, water use for large landscapes will not be discussed in this section, as it has been addressed in the "Landscape Irrigation" section earlier in this chapter. The CII landscapes with mixed-use meters (indoor and outdoor use on one meter) are included in this section, because they are distinctly different from large landscapes, such as parks and golf courses.

Commercial, Industrial, and Institutional Water Uses

There are limited centralized data concerning how much water is used in the CII sectors. Data on the numerous end uses are even more scattered. However, water uses within the CII sectors can be grouped into the following common uses (Pacific Institute 2003; California Department of Water Resources 2012a): process, restrooms, cooling, landscaping, kitchen, and laundry. With the exception of process water use, these end uses are very similar among CII users.

- Process — Process water inefficiencies include poorly adjusted equipment; leaks; use of outdated technology or equipment that is not water-efficient, or both; and use of potable water where alternatives, such as recycled or reused water, or waterless processes may be appropriate.
- Restrooms — Restroom usage is one of the higher end uses in CII. Inefficiencies in this area are similar to those in the residential sector; these include older toilets with high-volume flush rates and high-volume faucets. Waterless and low-flow urinals are components unique to the CII sectors, and these have brought significant savings to CII customers.
- Cooling — Water is used for cooling heated equipment, cooling towers, and air conditioning. Inefficiencies include improper adjustments made by system operators; system leaks; and the use of older, inefficient equipment.
- Landscape — Inefficiencies in CII landscape, as with other landscapes, include poorly designed and maintained irrigation systems, excessive watering schedules, and landscape designs that rely on high-water-using plants, especially cool-season turf, where low-water-using plants could provide the same benefit.
- Kitchen — The majority of the water used in the kitchens is for pre-rinsing, washing dishes and pots, making ice, preparing food, and cleaning equipment. Pre-rinse spray-valve retrofit programs have been, and continue to be, effective water efficiency programs. Inefficiencies in kitchen water use include usage of old machines, high-volume spray valves, and cooking practices and techniques.
- Laundry — Water savings can be achieved through use of more efficient washers.

PLACEHOLDER Box 3-8 Process Water

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Water Recycling and Reuse in the Commercial, Industrial, and Institutional Sectors

The use of recycled water (treated municipal effluent) or the reuse of process water within an industrial facility can play an important part in reducing CII water demand. With appropriate management, many non-potable water uses can be supplied with these alternate sources, such as cooling, washing, irrigation, and toilet flushing.

Recycled water provides 209,500 af of fresh water a year to CII sectors, including power plants. Saline water use from coastal sources also provides additional water primarily to the mining and steam electric power plants, estimated at 14.5 maf per year (California Department of Water Resources 2012a).

Water reuse opportunities exist in almost all industrial plants and are a growing focus of industry. Water reuse can range from reusing relatively clean rinse water for initial washing processes to the capture of rainwater or air conditioning condensate for use in irrigation or a cooling tower.

Water Agency Actions

Each water agency will face a unique blend of CII customers and will need to tailor the implementation of their CII water conservation program to fit local needs and opportunities. However, certain actions will assist water agencies in increasing CII water use efficiency to meet 2020 targets. These include identifying the highest users of CII water within the agency and offering or otherwise supporting water use surveys for these customers, continued and more aggressive conversions of mixed-use meters to dedicated landscape meters, and continued retrofitting of older toilets to ULFT and HET.

Commercial, Industrial, and Institutional Task Force

In response to the complexity of the CII sectors and the lack of data available on CII water use, the SB X7-7 legislation called for a Commercial, Industrial, and Institutional Task Force (CII Task Force) to address CII water use efficiency, including development of alternative BMPs and metrics for water use in CII sectors, as well as identifying barriers to the use of recycled water. The CII Task Force wrote a report of its findings and recommendations to the Legislature (California Department of Water Resources 2012a).

<u>Assessment for Appropriateness of Best Management Practices</u>

The CII Task Force identified a wide range of BMPs for use in the CII sectors. All of these BMPs are technically feasible and cost-effective in certain situations; however, the appropriateness of using any single BMP must be assessed for each site by the site operator or owner. The CII water user would need to conduct an audit of the site to determine which BMPs would be technically feasible and conduct a cost/benefit analysis to determine whether it is cost-effective to implement the BMPs. Organizations representing business and industry, water suppliers, the CUWCC, and DWR should educate CII businesses on the BMPs and approaches to doing audits and a cost-effectiveness analysis.

<u>Commercial, Industrial, and Institutional Task Force Recommendations</u>

The CII Task Force draft report (California Department of Water Resources 2012a) includes the following recommendations:

- **CII Best Management Practices**
  - Although many CII water users have implemented water efficiency measures, much more remains to be done in these sectors. CII customers should be encouraged to implement the BMPs identified in the CII Task Force report, such as:
    - Adjusting equipment and fixing leaks.
    - Modifying equipment, installing water-saving devices, and improving operational efficiencies.

        - Using automated systems.
        - Replacing older, inefficient equipment with new, water-saving equipment.
        - Reusing water on site or using recycled municipal wastewater.
    - CII customers should perform audits to identify opportunities for BMP implementation and implement all cost-effective BMPs.
- **Efficiency Standards and Metrics**
    - The appropriate entities should set efficiency standards for certain water-using devices and equipment, similar to existing device standards for commercial pre-rinse spray valves and clothes washers. Codes and standards could be updated to reflect the most current efficiency standards.
    - Develop appropriate metrics for tracking CII water use efficiency improvements.
- **Recycled and Alternative Water Use**
    - Improve statutory and regulatory requirements to overcome barriers to the use of recycled water in a manner that is protective of public health and the environment.
    - Stakeholders and DWR should encourage financial and technical assistance to increase recycled and alternative water use.
- **Ongoing Support**
    - DWR and the CUWCC should identify and develop a mechanism to ensure that critical issues in CII water conservation are addressed.
    - Improve statewide collection of water use data to better characterize and track water use in the CII sectors.

PLACEHOLDER Box 3-9 California Prisons Reduced Annual Water Use by 21 Percent

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Projected Commercial, Industrial, and Institutional Savings

Because of the lack of sufficient water use data for the CII sectors, and the fact that water conservation potential varies greatly among technologies, industries, and regions, determining a value for projected savings is challenging.

However, the SB X7-7 legislation and the CUWCC MOU both point to a target savings in the CII sectors of 10 percent from the baseline. In order to maintain consistency with the legislation and the MOU, DWR will also use the value of 10 percent to project CII water savings.

These potential CII water savings exclude savings from large landscapes, which are included in the “Large Landscapes (Dedicated Meters)” portion of this chapter.

The volume of potential savings in the CII sectors (af) is derived by multiplying CII baseline water use (1.76 maf) by the assumed 10-percent reduction (1.76 maf X 10%). The resulting savings are 176,000 af, which equates to 4.8 gpcd.

Water Loss Control in Distribution Systems

This section addresses water loss due to leaks in the distribution system of a water supplier. Leaks in the residential and CII sectors are addressed in their respective sections of this chapter.

Water loss control consists of the auditing of water supplies and implementation of controls to keep system losses to a minimum. A report by Southern California Edison (2009) estimated that 10 percent of the total volume of water supplied statewide is lost to leaks, which equals 0.88 maf. Addressing this loss is a major challenge to water suppliers, many of whom have aging water distribution systems in need of repair yet lack adequate funding for extensive water main replacement.

Audits

Water auditing is crucial to identifying the economically viable options that can be implemented for water loss control. Water utilities that do not perform water audits are most likely to be unaware of the level of real losses in their systems, making it unlikely for them to implement BMPs to curb these loss volumes.

A new standard method for conducting water audits was co-developed by the American Water Works Association (AWWA) and the International Water Association (IWA). The AWWA/IWA water audit method is effective because it features sound, consistent definitions for the major forms of water consumption and water loss encountered in drinking water utilities. It also features a set of rational performance indicators that evaluate utilities on system-specific attributes, such as the average pressure in the distribution system and the total length of water mains.

The AWWA/IWA water audit method is detailed in the AWWA's manual *Water Audits and Loss Control Programs* (2009). The AWWA also offers free software for this auditing method that assists in tracking water consumption and losses and calculates the costs of losses, giving agencies important information for assessing the cost-effectiveness of leak reduction measures.

This new standard water audit is now a requirement for implementation of BMP 1.2 (see Table 3-1 for a list of all BMPs). All water agencies that are members of the CUWCC, as well as any agencies that seek funding from the State of California, are obligated to complete the standard water audit annually, to improve the quality of data collected on water loss, and to reduce water losses to the extent that is cost-effective.

Trenchless Pipe Repairs

Repairing leaky pipes can be an expensive and difficult proposition for agencies. Trenchless pipe repair is an emerging, cost-effective technology that offers an efficient alternative in pipe repair. Using this new technology, the damaged pipe is lined with a new cured-in-place pipe that seals all cracks, splits, and faulty joints. This trenchless technology requires no trenching or digging and can be done in much less time without large excavations, saving money, time, and labor and making repairs and maintenance more cost-effective.

Meters

Measurements of water use are a necessary component in developing water budgets and detecting leaks. Consumers and water agencies are aware of water use when it is being metered and monitored. The water use data can be mapped for trends to detect water loss. Consumer awareness leads to higher implementation of BMPs to conserve water. The 2010 DWR Public Water Systems Statistics estimates that 6 percent to 7 percent of connections in California are still unmetered. There are huge potential savings by metering water use. The CUWCC, in its memorandum of understanding (MOU), BMP 1.3, estimates a 20-percent savings when water meters are installed (California Urban Water Conservation Council 2009).

As of 2012, the California Water Code required full metering for customers of all urban water suppliers served by the federal Central Valley Project (CVP) by 2013. Full metering is required by 2025 for customers of all other urban water suppliers with unmetered service connections.

Although water meters aid in preventing water loss, a recent study by the U.S. Environmental Protection Agency (EPA) and the Water Research Foundation (2011) shows that water meters in service lose their accuracy through use. Low flows of 1/8 gpm may go unrecorded by meters that are set to run at 1/4 gpm. Water meters often need to be recalibrated and checked. Higher accuracy standards should also be considered to capture a greater share of low flows that are indicative of leaks.

Projected Savings

A report by Southern California Edison (2009) concluded that 40 percent of water loss is economically recoverable. Given that the estimated water loss in California is 0.88 maf, and that 40 percent of that is estimated to be economically recoverable, the calculated water savings from cost-effective water loss control is 0.35 maf, or 7 gpcd.

Combined Demand Reductions

Combining the estimated demand reductions from each sector, as detailed in the preceding paragraphs, the State of California could theoretically reduce demand for potable water in the year 2020 by more than 2 million af (Table 3-4).

PLACEHOLDER Table 3-4 Projected Savings by Sector

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Alternative Water Sources — Recycled Water, Desalinated Water, Gray Water, and Rainwater

Alternative water supplies are expected to further reduce statewide demand of potable water by the year 2020.

Alternative water sources vary in water quality, level of treatment, local availability, and suitability for intended uses. Recycled water and desalinated water undergo the highest level of treatment prior to use and are discussed in detail in Chapters 12 and 10 of Volume 3.

Residential rainwater capture and gray water reuse are sources of water that can be used without the high investment in infrastructure that recycled water or desalinated water require.

Rainwater capture is discussed at length in Chapter 20, “Urban Stormwater Runoff Management,” but it should be mentioned here that on-site rainwater capture, in the form of rain gardens, bioswales, pervious surfaces, and other landscape features, can reduce the amount of potable water needed for irrigation by replenishing soil moisture levels and shortening the irrigation season. A small to moderate-sized rain garden can collect thousands of gallons of water. For example, a demonstration rain garden at the Richardson Bay Audubon Center & Sanctuary in Marin County (Salmon Protection and Watershed Network 2010) can collect nearly 3,900 gallons of water in a 315-square-foot rain garden with approximately 22 inches of annual rainfall.

Although there is tremendous interest in rainwater capture with rain barrels and cisterns, California's dry summer climate brings into question the cost-effectiveness of small rain capture devices in many regions of the state. However, cisterns and other large-volume storage devices begin to become cost-effective in areas where the rainy season extends into the irrigation season or where supplied water is very expensive, unreliable, or difficult to convey. Unlike rainwater capture for irrigation, in which supply availability and demand are out of sync, rainwater capture for year-round indoor non-potable uses, such as toilet flushing, may be the most practical application. Rainwater standards are printed in the 2013 California Plumbing Code.

During the 2013 triennial code cycle, gray water standards were revised by the California Building Standards Commission (CBSC) and the Department of Housing and Community Development (HCD) and were organized in Chapter 16 of the California Plumbing Code. Gray water use will increase over time, partly due to changes in the gray water standards. The revised standards make it easier for a water user to install a gray water system; simple systems supplied by clothes washers or single fixtures do not require a building permit if certain conditions are met.

In its 2010 UWMP, the Los Angeles Department of Water and Power features a case study of alternative water use by one of its residential customers. In addition to collecting rainwater in 18 rain barrels, the customer installed a gray water system using the waste water from her clothes washer. The clothes-washer-supplied gray water system generates approximately 7,000 gallons of water per year by the family of three. By adding the shower and bathroom sink to the gray water system, the water generated for landscape irrigation could exceed 53,000 gallons of gray water per year.

The *California Single Family Home Water Use Efficiency Study* (Irvine Ranch Water District 2011) found that the annual estimated irrigation demand averages about 90,000 gallons per year at the homes studied. Based on this assumption, this family could offset nearly 60 percent of its irrigation demand by the expanded gray water system. Under the new gray water standards, a plumbing permit is not required if the plumbing is not altered and if health and safety conditions are met.

The Importance of Conservation Rate Structures

Conservation rate structures are rates set by water agencies to provide price signals to consumers and encourage water conservation. Conservation rates are also known as volumetric rates, because the customer bill reflects the volume of water used. These structures can be applied to water supply as well as wastewater (sewer) services.

Properly constructed rates can be significant in motivating customers to save water. When determining conservation rate structures, water suppliers must also ensure revenue stability. This is done through a combination of variable and fixed revenues, which ensure that adequate funds are provided to operate and maintain the system even when water use is declining.

PLACEHOLDER Box 3-10 Consumption-Based Fixed Rates, City of Davis

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Some examples of conservation rate structures are listed below.

- Increasing block tier structures: The cost per unit of water increases as the consumer uses more water.
- Seasonal rates: Water rates are set higher during the summer months, when peak usage occurs.
- Water budget structures: Each residence has an inclining block rate structure designed according to the number of occupants, landscape area, local climate, and possibly other factors. The prices of the tiers increase significantly after the base usage tier has been reached.
- Water budgets with punitive tiers when budgets are exceeded: Often the revenue generated from punitive tiers is used to fund the conservation programs.

Flat rates, where customers' bills do not reflect the volume of water used, are not considered conservation rates because they do not send a price signal to the consumer and do not encourage conservation.

PLACEHOLDER Box 3-11 Successful Conservation Rate Structure: Irvine Ranch Water District

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

nservation Rate Structures for Wastewater Services

Although roughly 90 percent of California households served by a public water supplier pay for drinking water through a volumetric rate, about 70 percent of such California households pay for sewer service through a flat, non-volumetric charge. And sewer charges can be significant: In some jurisdictions sewer charges can be equal to, or greater than, water charges. ~~By billing sewer service at a flat rate, the price signal rewarding water efficiency is being cut in half for a majority of California households.~~

Water efficiency can reduce future infrastructure requirements for sewer service, and volumetric pricing for sewer service is encouraged by the EPA, the Water Environment Federation, and the CUWCC.

Installation of new hardware is generally not required in order to begin volumetric billing for wastewater, but where water and sewer are provided by different agencies, interagency cooperation is needed, and billing software modifications are likely (Chesnutt et al. 1994). Volumetric wastewater pricing requires access to metered water consumption records and the ability to generate a customer bill. Sewer agencies currently billing fixed charges on a combined water-wastewater bill would have the fewest implementation constraints. A sewer agency whose service area cuts across multiple water agency service area boundaries would face more implementation challenges.

A 2011 report (A&N Services Inc. 2011) presented a roughly 4-percent reduction in residential water use, with a 10-percent sewer service rate increase.

Potential Benefits

Urban Water Use Efficiency

Using water efficiently yields multiple benefits, including:

- Increased reliability of water supplies.
- Increased capacity to meet the growing water demand of California's increasing population.
- Delayed capital costs for new infrastructure to treat and deliver water.

- Reduced contaminated irrigation runoff to surface waters.
- Reduced volume of wastewater, thus reducing capital costs and ongoing treatment costs.
- Increased availability of water for surface or groundwater storage.
- Reduced water-related energy demands and associated greenhouse gas (GHG) emissions.

PLACEHOLDER Box 3-12 Reducing Irrigation Runoff Helps Local Waterways

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

PLACEHOLDER Box 3-13 Climate Change and Water Use Efficiency: the Energy-Water Nexus

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Climate Change

Urban water suppliers and water users may be particularly vulnerable to changes in climate because they require highly reliable water supplies and because demands for water tend to grow over time with population. While some agricultural water users may be able to temporarily reduce water use by fallowing land or changing cropping patterns, urban water uses tend to have much less flexibility. Urban water use efficiency provides a key strategy for addressing these vulnerabilities.

Key impacts of climate change that relate to urban water supplies include:

- Warming temperatures, increasing water usage, particularly for outdoor irrigation.
- Decreasing snowfall, reducing the natural water storage found in the Sierra Nevada snowpack.
- Precipitation shifting from snow to rain, requiring a change in water supply management.
- Rising sea levels:
  - Threatening water supply infrastructure in coastal communities.
  - Increasing seawater intrusion into coastal freshwater aquifers.
  - Reducing water exports from the Delta.
- Increasing frequency of floods, droughts, and wildfires damaging watersheds that provide water to urban communities.

To help address these climate-related challenges, State and federal agencies have developed several programs that provide guidance and information to urban water suppliers. In 2011, the DWR, the EPA, the U.S. Army Corps of Engineers, and the Resources Legacy Fund cooperatively developed *Climate Change Handbook for Regional Water Planning* (online at http://www.water.ca.gov/climatechange/CCHandbook.cfm), which provides a comprehensive resource for regional water managers but includes information that will be useful to urban water managers as well. Even more focused on urban water providers is the U.S. EPA's Climate Ready Water Utilities program (online at http://www.epa.gov/infrastructure/watersecurity/climate), which provides guidance and tools specifically for water utilities to incorporate climate change into their planning and operations.

Adaptation

Water conservation and water use efficiency are considered primary climate change adaptation strategies — those that should be undertaken first because they are generally lower-cost and provide multiple benefits. By implementing practices that make the most of available water supplies, practices that reduce waste and increase efficiency, the urban water use sector will be better equipped to adapt to potential reductions in water supply.

Mitigation

Supplying and treating water for urban use requires a high amount of energy, which in turn contributes to greenhouse gas emissions and climate change. Reducing the amount of water used in the urban setting reduces the energy used, thus mitigating impacts to climate change. Urban water use efficiency is both a mitigation measure and an adaptation measure for climate change. Box 3-13 highlights the connection between urban water use, energy, and greenhouse gases.

Potential Costs

Increasing the supply of water has the same effect on water availability as decreasing the demand for water (through increased efficiency). However, historically reliable methods for increasing supply, such as building new dams for surface storage, or increasing water exports from the Delta, are less certain as California moves into the future. Many water suppliers are turning to other strategies, such as improving efficiency, to meet increasing demand. And as the costs for increasing water supply go up, even the more expensive conservation strategies may become economically viable in the future.

Table 3-5 shows some examples of costs for water use efficiency practices. These costs will vary from supplier to supplier, but they are provided here as an illustration of what can be reasonably expected.

PLACEHOLDER Table 3-5 Sample Costs of Water Use Efficiency to Water Suppliers per Acre-Foot of Water Saved

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

It is conservatively estimated that a well-implemented set of water conservation programs would cost a water supplier an average of $333-$500 per af (Alliance for Water Efficiency 2008).

PLACEHOLDER Box 3-14 San Diego: Comparing Water Source Options

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

There are other important water conservation programs that cannot be quantified in terms of cost per af of water saved. These include designating and supporting a water conservation coordinator, implementing education and outreach programs, using water conservation rate structures, and developing and implementing a water waste prohibition ordinance.

Major Implementation Issues

Reduced Water Agency Revenue for Water Conservation

Because of the economic downturn, many water agencies have reduced their staff and other expenditures for water conservation. This reduction comes at a difficult time, when water agencies will need to increase, or at least maintain, the level of conservation in their districts in order to meet the 20-percent reduction by 2020.

Rate Structures and Water Agency Revenue

Providing customers with correct price signals to use water efficiently is not a simple task. The appropriate signals may vary from agency to agency and from community to community. And if the price structure is not set up correctly, the resulting water conservation can negatively affect the amount of revenue collected by a water supplier. The less water customers use, the less revenue the water supplier receives, which creates a disincentive for the water agency to encourage conservation. Also, because of seasonal variation in water use, some price structures may increase variability and fluctuation of water utility revenues.

This problem poses a hardship on the utility's ability to meet its revenue requirements and can undermine the financial viability of their systems and the ability to meet service needs and infrastructure maintenance.

The process for changing rate structures can also be challenging in and of itself. Regulations impose certain limitations, public support can be difficult to gain, and water board elections may influence the willingness of board members to agree to rate changes.

Lack of Public Awareness Regarding Landscape Water Use

Most homeowners are not aware that the majority of their water use takes place in the landscape, nor are they aware that much of that irrigation water is used inefficiently. In the 2007 *Statewide Market Survey: Landscape Water Use Efficiency* (California Urban Water Conservation Council 2007c), the researchers found that most respondents either had no idea how much water they used in their landscapes, or they believed their water use was below the statewide average. Coupled with the tendency to leave irrigation controllers on the default setting year round and a lack of irrigation system maintenance, a statewide education campaign is needed to educate water users and increase awareness of meaningful actions that will save water in landscapes.

Landscape Area Measurement for Water Budgets

Knowing the area of a landscape is critical to developing a water budget for the site. A water budget, in turn, will assist in determining whether the landscape is being watered efficiently.

Many water suppliers have not determined the extent of landscape area in their service area. Impediments to measuring or estimating landscape area include the high cost of physically measuring the site or purchasing satellite imagery, a lack of expertise in utilizing available satellite data, linking the parcels with customer data, segregating areas served by multiple meters, and assessing the density of vegetated canopies.

Inconsistent Implementation of the Model Water Efficient Landscape Ordinance

By the end of 2010, 333 local land use agencies had reported on the status of adoption of water efficient landscape ordinances. However, it is not known how consistently local agencies enforce water efficient landscape ordinances. Local agencies are challenged by the complexity of landscape and irrigation design requirements and a lack of staff to review and inspect landscape. The common disconnect between water suppliers and land use authorities further complicates the issue.

Data on Industrial Water Use Are Limited

The last survey published by DWR to obtain valid information on industrial water use (Bulletin 124-3) was conducted in 1979. This information is out of date, but no current data exist. The survey determined rates of industrial water use (including both water agency and self-supplied water sources), quantities of water recycled by industry, and quantities of wastewater discharged by industry.

Water Loss

The amount of water lost due to leakage in the distribution system of the State's water suppliers is not well known. This is largely due to the fact that not all water suppliers perform regular water loss audits. If water audits are not conducted, it is difficult for a water agency to know the extent of its losses and unlikely that the agency will implement BMPs to reduce these losses.

Lack of a Standardized Efficiency Measure for California Urban Water Suppliers

One of the limitations to the development of the 20x2020 Plan goal was the lack of an effective measure of the level of water use efficiency in a supplier's service area. The gpcd is useful to track changes in water use in individual water agencies over time, but due to differences in landscape area, climate, and CII water use it is not useful as measure of efficiency. The lack of a standard measure of supplier efficiency is one reason that four different methods for setting a 2020 water use target were provided in the SB X7-7 legislation.

Recommendations

1. **Assist Utilities in Developing Sustainable Conservation Rate Structures —** DWR, in partnership with the CUWCC, the U.S. Bureau of Reclamation, the California Public Utilities Commission, the Association of California Water Agencies (ACWA), the California Water Association, and water agencies should lead an investigation to analyze and evaluate the effectiveness of rate structures in conserving water and meeting water agency revenue requirements. DWR should disseminate the findings and recommendations from the study, as well as guidance to water agencies, throughout the state by way of regional workshops and a detailed page on the DWR Web site.
2. **Expand the Save Our Water Campaign —** DWR, in coordination with ACWA, the CUWCC, water suppliers, local stakeholders, and irrigation manufacturers, should expand the statewide Save Our Water campaign. Initially, the landscape portion of the campaign should focus on cost-effective ways to improve irrigation system function and irrigation controller programming.
3. **Assist Water Agencies in Landscape Area Measurement and Water Budgets —** DWR, in coordination with the CUWCC, should assist water suppliers in finding easy and inexpensive ways to obtain landscape area data for parcels in their service areas and offer workshops that highlight successful programs. As a priority, water agencies should measure the landscape area for sites with dedicated meters first, because their landscape water use is known. A comparison

of water use and water budget will immediately determine if the landscape is being watered efficiently. Water agencies can then target the sites that are over-irrigating, a cost-effective method for reducing landscape irrigation demand.

4. **Increase Landscape Water Management Skills —** Water use efficiency is most easily achieved on landscapes with properly designed and installed irrigation systems and managed with water budgets. To make this possible, the Contractors State License Board should increase the emphasis and testing requirements in the C-27 Landscape Contractor's exam in the subject areas of irrigation design and installation and water budgeting to ensure landscape professionals have the needed skills. DWR, water suppliers, and the landscape industry should increase opportunities to improve water management skills of non-English-speaking workers and workers that do not hold a contractor's license.
5. **Update the Model Water Efficient Landscape Ordinance —** DWR should work with local agencies, local water suppliers, and the landscape industry to identify and remove barriers to implementation of the MWELO. The MWELO should be updated periodically based on new findings, innovation, and technological improvements.
6. **Encourage Innovation in Irrigation Equipment Design That Increases Durability, Reliability, and Ease of Use —** The irrigation manufacturing industry should work with the landscape industry, universities, and other industries to develop irrigation equipment, sensors, and controllers that are more durable and easier to install, maintain, and program.
7. **Update the Survey of Industrial Water Use —** Because the last published survey on industrial water use in California was conducted in 1979, and updated data are needed by local agencies and the State in order to better manage industrial water use, DWR should update the survey of industrial water use, Bulletin 124-3. The survey should provide information on the rates of industrial water use (including both water agency and self-supplied water sources), quantities of water recycled by industry, and quantities of wastewater discharged by industry.
8. **Require Water Audits in 2015 Urban Water Management Plans —** In order to reduce water loss in water distribution systems, the Legislature should revise the Urban Water Management Planning Act to require water suppliers to complete the AWWA auditing program and report their water audit, water balance, and performance indicator in their 2015 UWMPs. Signatories to the CUWCC MOU are already required to perform this audit annually. Water audit data reported to the CUWCC provided valuable information on the extent of water losses that can be economically recovered by the water agencies. More on the AWWA auditing program can be found at http://www.awwa.org/resources-tools/water-knowledge/water-loss-control.aspx.
9. **Develop a Standardized Efficiency Measure for California Urban Water Suppliers —** Through a public process, DWR should develop a standardized water use efficiency measure for California urban water suppliers. The measure would be used to determine efficient water use for urban water suppliers and would account for differences in irrigated landscape area, climate, population, and CII water use. The single standardized measure for supplier water use efficiency would better permit customers, utilities, and State officials to evaluate the efficiencies of California urban water suppliers across the state.
10. **Investigate Gray Water Use in New Residential Applications —** In cooperation with water suppliers and developers, DWR should conduct a pilot study of gray water installation in new homes. The study should evaluate gray water use in landscapes and the feasibility of installing gray water systems in new homes.

Other Related Resource Management Strategies

Chapters within this volume that relate to urban water use efficiency are listed below.

- Chapter 9, "Conjunctive Management and Groundwater."
- Chapter 10, "Desalination — Brackish Water and Seawater."
- Chapter 12, "Municipal Recycled Water."
- Chapter 8, "Water Transfers."
- Chapter 15, "Drinking Water Treatment and Distribution."
- Chapter 17, "Matching Water Quality to Use."
- Chapter 20, "Urban Stormwater Runoff Management."
- Chapter 24, "Land Use Planning and Management."
- Chapter 25, "Recharge Area Protection."
- Chapter 28, "Economic Incentives — Loans, Grants, and Water Pricing."
- Chapter 29, "Outreach and Engagement."

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Table 3-1 Best Management Practices

Foundational BMPs (ongoing practices implemented by all signatories to the MOU) [a]		Programmatic BMPs (practices with alternatives for implementation)	
BMP No.	**Description**	**BMP No.**	**Description**
BMP 1.1. Utility Operations Programs — Operations Practices	Designate a water conservation coordinator for the agency. Implement and maintain a water waste prohibition ordinance or regulation. Implement prohibitions on gutter flooding, single-pass cooling systems, and non-recirculating water. Monitor water softener efficiency and usage. *Old BMP numbers: 10, 12, and 13.*	BMP 3. Residential	Conduct indoor and outdoor residential water use surveys. Implement an enforceable ordinance or provide incentives to replace high-flow water use fixtures with low-flow counterparts. Offer rebates for high-efficiency washers. Offer rebates for high-efficiency, low-flow toilets. *Old BMP numbers: 1, 2, 6 and 14.*
BMP 1.2. Utility Operations Programs — Water Loss Control	Implement a full-scale system water audit, maintain in-house records of audit results and completed American Water Works Association audit worksheets. *Old BMP number: 3.*	BMP 4. Commercial, Industrial, and Institutional	Rank commercial, industrial, and institutional customers according to use. Implement either a CII [b] water use survey and customer incentives program or CII conservation program targets. *Old BMP number: 9.*
BMP 1.3. Utility Operations Programs — Metering	Install water meters for all new connections and bill by volume of use. Implement a program for retrofitting existing unmetered connections and bill by volume of use. *Old BMP number: 4.*	BMP 5. Landscape	Develop marketing and targeting strategies for landscape surveys. Implement water use budgets for large landscapes. *Old BMP number: 5.*
BMP 1.4. Utility Operations Programs — Pricing	Implement rate structures and volumetric rates for water service by customer class. *Old BMP number: 11.*		
BMP 2. Education Programs — Public Information Programs	Maintain an active public information program about water conservation. Implement a school education program to promote water conservation. *Old BMP numbers: 7 and 8.*		

Source: California Urban Water Conservation Council 2009.

Notes:

[a] BMP = best management practices. MOU = memorandum of understanding.

[b] CII = commercial, industrial, and institutional.

Table 3-2 Statewide Urban Water Uses

Sector	Percentage	Volume [a]
Residential landscape	35%	3.0 maf
Large landscape	10%	0.9 maf
Indoor residential	31%	2.7 maf
Commercial, institutional, and industrial	20%	1.7 maf
Other	5%	0.5 maf
Total	100%	8.8 maf

Source: California Department of Water Resources 2009.

Note:

[a] maf = million acre-feet.

Table 3-3 Potential Savings for Indoor Residential Water Use

Use	Savings [a]
Toilets	5 gpcd [b]
Showers	1 gpcd [b]
Leaks	3 gpcd [d]
Faucets	1 gpcd [c]
Clothes washers	4-6 gpcd [b]
Total	15 gpcd

Notes:

[a] gpcd = gallons per capita per day.

[b] Source: 20x 2020 Agency Team on Water Conservation 2010.

[c] Source: Irvine Ranch Water District 2011.

[d] Sources: Derived from Irvine Ranch 2011 and Pacific Institute 2003.

Table 3-4 Projected Savings by Sector [a]

Demand reduction sectors	Reduction [b]	Projected savings in 2020 [c]
Large landscape	3 gpcd	148,000 af
Commercial, industrial, and institutional	4 gpcd	197,000 af
Residential interior	15 gpcd	739,000 af
Residential exterior	16 gpcd	789,000 af
Water loss control	7 gpcd	345,000 af
Total	45 gpcd	2,218,000 af

Notes:

[a] The figures in this table are a summary of projected savings that are detailed in preceding pages.

[b] gpcd = gallons per capita per day.

[c] af = acre-feet.

Table 3-5 Sample Costs of Water Use Efficiency to Water Suppliers per Acre-Foot of Water Saved

Program types	Sample costs per acre-foot
Residential programs [a, b, c, d, e]	Toilet rebates: $158-$475/af
	Residential audits: $236-$1,474/af
	Clothes washer rebates: $154-$480/af
Landscape programs [a, b, d, e]	Landscape audits: $58-$896/af
	Equipment rebates: $15-$181/af
	Turf removal: $274-$717/af
	Water budgets: $10-$59/af
Commercial, industrial, and institutional (CII) programs [b, c, f, g]	Toilet rebates: $242-$1,018/af
	Urinal replacement: $320-$583/af
	Pre-rinse spray valves: $78/af
Utility operations programs [d, h]	System audits/leak detection: $203-$658/af

Notes:

[a] Source: City of Paso Robles 2010.

[b] Source: Los Angeles Department of Water and Power 2010.

[c] Source: California Urban Water Conservation Council 2004, 2005a, 2006, 2007a.

[d] Source: Marin Municipal Water District 2010.

[e] Source: City of Sacramento 2010.

[f] Source: East Bay Municipal Utilities District [date unknown].

[g] Source: Alliance for Water Efficiency 2012.

[h] Source: California Urban Water Conservation Council 2007b.

Figure 3-1 Average Baseline Water Use by Hydrologic Region

The map below displays the average water use, by hydrologic region, during the baseline period, roughly 1996 through 2005. The numbers displayed are in gallons per capita per day (GPCD) (California Department of Water Resources 2012b). The hydrologic regions near the coast generally have smaller landscapes and cooler climates compared with inland regions, which have larger irrigated landscapes and warmer climates.

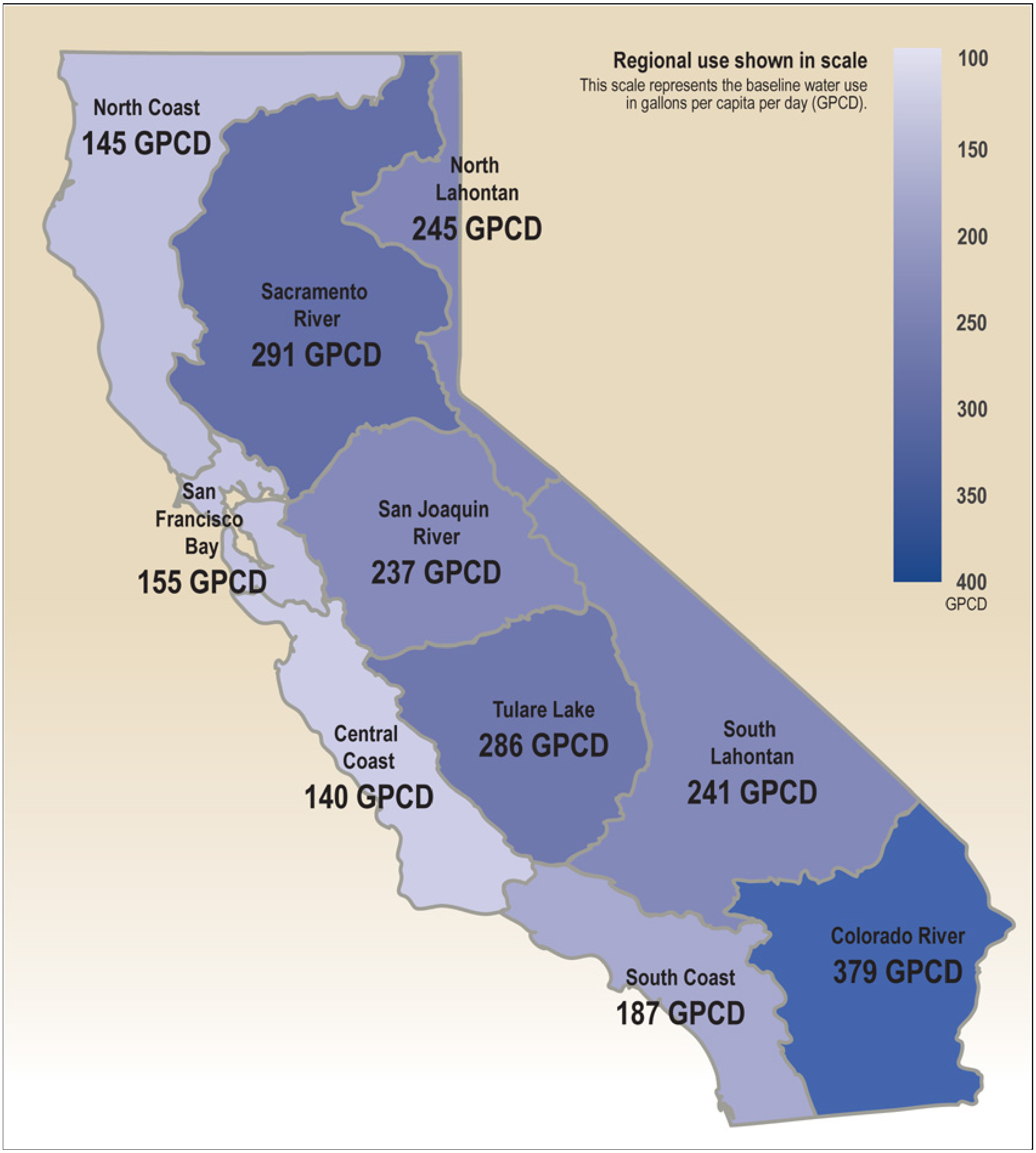


Figure 3-2 Baseline Water Use

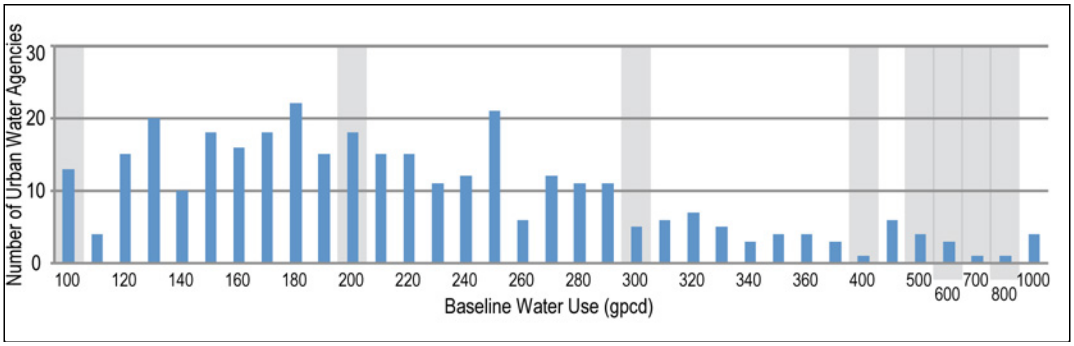
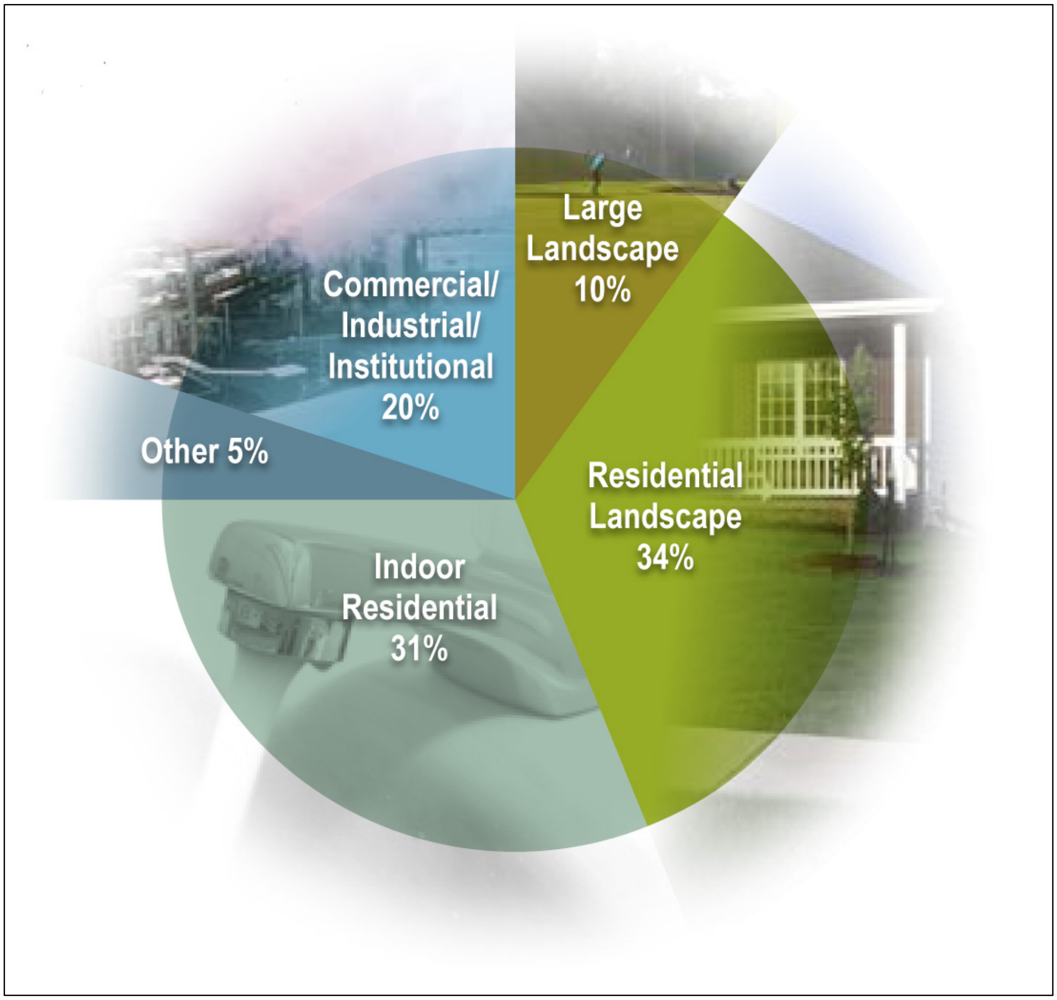


Figure 3-3 Statewide Urban Water Use: Eight-Year Average, 1998-2005

This pie chart illustrates the relative water use of different sectors as a statewide average. The water use by sector will vary for each individual water agency.



Source: California Department of Water Resources 2009

Figure 3-4 Estimated Indoor Residential Water Use in California (Year 2000)

Source: Pacific Institute 2003

Box 3-1 20x2020 Plan: History, Process, and Impact

History

In 2008, the Delta Vision Blue Ribbon Task Force called for improved water use efficiency and conservation in order to reduce exports from the Sacramento-San Joaquin River Delta (Delta). The task force specifically recommended a statewide 20-percent per-capita reduction in water use by the year 2020. In response to this recommendation, the 20x2020 Agency Team on Water Conservation was formed. The agency team subsequently wrote the *20x2020 Water Conservation Plan* (20x2020 State Agency Team on Water Conservation 2010) outlining recommendations on how statewide per-capita water use reductions could be successfully implemented to meet the goal of 20-percent reduction by 2020.

In November 2009, the Water Conservation Act of 2009, Senate Bill No. 7 of the 7th Extraordinary Session (SB X7-7), was enacted by the California Legislature (California Water Code Section 10608). The urban water conservation provisions of SB X7-7 reflect the approach taken in the *20x2020 Water Conservation Plan* and set an overall goal of reducing per-capita urban water use statewide by 20 percent by 2020.

The SB X7-7 legislation also directed the California Department of Water Resources (DWR) to address the following urban water use efficiency issues:

- Convene a task force to investigate alternative best management practices for the commercial, industrial, and institutional sectors (the Commercial, Industrial, and Institutional Task Force).
- Establish a standardized water use reporting form.
- Promote regional water resource management through increased incentives and decreased barriers.
- Develop statewide targets for regional water management practices such as using recycled water, using brackish groundwater, desalination, and urban stormwater infiltration and direct use.

The 20x2020 Plan Process

Water suppliers play a fundamental role in carrying out the statewide water reduction goal of 20 percent by 2020. Each urban water supplier is required to set water use targets based on its historical water use, the local climate, and locally implemented conservation programs. (“Urban water supplier” is defined in California Water Code Section 10617.) The statewide goal will be met by compiling the water reductions from each water supplier.

The legislation does not require a reduction in the total volume of water used in the urban sector. That is because other factors, such as changes in economics or population, will affect water use. Rather, the legislation requires a reduction in per-capita water consumption. Water consumption is calculated in gallons per capita per day.

As set out in the SB X7-7 legislation, and through the use of methodologies and criteria in *Methodologies for Calculating Baseline and Compliance Urban Per Capita Water Use* (California Department of Water Resources 2011), water suppliers:

- Must determine their baseline water use and target water uses for 2015 and 2020. Wholesale suppliers are not required to set targets but are directed to assist their retail suppliers in meeting the targets.
- Must report their gross water use during the final year of the reporting period (years 2015 and 2020). This is known as “Compliance Water Use.”
- May revise their baseline water use calculations and change the method used to set their targets after submitting their 2010 urban water management plans.

Impact of the 20x2020 Plan

Projecting forward to the year 2020, with statewide population expected to be in the range of 44 million people, a decrease in per-capita water use of 20 percent would equate to an annual demand reduction of 2 million acre-feet of water.

The requirement that all urban retail water suppliers quantify per-capita baseline water use, set water use targets, and then show actual reductions in 2015 and 2020 has caused suppliers across California to pay particularly close attention to the effectiveness of their water conservation programs.

Box 3-2 Demand Hardening

Demand hardening is the assumed phenomenon by which customers find it more difficult to reduce demand because they have already implemented significant conservation measures.

Some water utilities have expressed concern that, because of the high degree of conservation already implemented in their districts, demand hardening may limit their ability to respond to drought and to meet 2020 water use reduction targets.

In response to this concern, the California Department of Water Resources and others sponsored the study *An Assessment of Demand Elasticity during Drought* to investigate how demand hardening may affect water agencies (Fryer 2013). Seven water agencies were selected for the study, four of which were in California. Each of these agencies had implemented significant demand management programs and had experienced drought events. Case studies of these agencies included investigation of water use histories; drought histories; water price trends; water conservation actions; local climate; demographics; economic patterns; and interviews with utility staff, community leaders, and residential customers. The project study period was 1970 through 2011.

Initial results from the study show that these water agencies, though highly saturated with conservation measures in recent years, did not appear to have greater difficulty meeting requested water use reductions. The study concluded that typical water utilities would only need to factor in demand hardening if planning for rationing in excess of 35 percent, and even at that point the effect of demand hardening was expected to be minor.

The study identified several areas that alleviated demand hardening:

- <u>Landscape irrigation.</u> It appears that a 50-percent reduction in landscape water use during serious droughts is possible. Turf irrigation can be cut back and is usually one of the first steps taken to save water. Low-water-use plants show a high potential to tolerate water stress. Water agencies may experience even greater landscape water savings depending on the level of landscape irrigation restrictions that are put into place.
- <u>Behaviors.</u> Water users typically meet or exceed conservation goals during drought and appear to be receptive to trying new conservation measures.
- <u>Improving standards and technology.</u> None of the agencies in the study had reached 100-percent saturation of conservation fixtures (low-flow faucets, toilets, etc.). And as new water-saving technologies reach the marketplace and efficiency standards continue to improve, 100-percent saturation will be an evolving target.
- <u>Allocating conserved water to support new growth.</u> When conserved water is allocated to new customers within an agency's service area, the water savings that may be required during a drought will be divided among a larger number of customers. The amount of required conservation for each customer will be less, effectively easing demand hardening.

Box 3-3 Landscape Irrigation Runoff

The photo below shows an example of irrigation runoff, frequently seen in landscapes throughout California.

Fortunately, many opportunities exist to improve efficiency in landscape irrigation. These include the use of evapotranspiration controllers, reduction of cool season turf, and education of water users.

The Residential Runoff Reduction Study (Municipal Water District of Orange County and Irvine Ranch Irrigation District 2004) demonstrated that a combination of evapotranspiration controllers and user education can greatly reduce dry season irrigation runoff.

In this study, dry season irrigation runoff was measured from 138 residential and non-residential landscapes. After the runoff was measured, the landscapes were retrofitted with evapotranspiration controllers, and the water users were educated in efficient irrigation practices. A second set of runoff measurements was taken after the retrofit and user education.

A comparison of the first and second measurements showed that irrigation runoff had been reduced by 50 percent by the installation of evapotranspiration controllers and user education.

PLACEHOLDER Photo A Irrigation Runoff

[For the public review draft, the draft photo follows this box.]

Photo A Irrigation Runoff

[photo to come]

Box 3-4 The Value of Landscape Water Budgets

Landscape water budgeting is a straightforward method for determining whether a site is receiving the correct amount of water to keep the plants healthy without wasting water. A water budget is calculated using local reference evapotranspiration data, an evapotranspiration adjustment factor, and the area (in square feet) of the irrigated landscape. The landscape area can be captured from landscape plans, by measuring the site, or through aerial imagery. Historically, obtaining the landscape area has been a challenge for water suppliers, especially when more than one meter may serve a parcel, but new tools and technology are becoming available that will simplify the process.

When the volume of water allowed in the water budget is compared with water use data, the irrigation manager can evaluate whether water use is on track and, if it is not, can make immediate changes to the irrigation schedule. Because weather conditions influence the water needs of plants, irrigation managers should assess compliance with the water budget weekly or at least monthly.

Water budgets are valuable communication tools. An irrigator that keeps a site within a water budget can show its customer the water savings and cost savings achieved when compared with historical use. Water suppliers can assign a water budget to an account and notify the customer when the budget is exceeded. Tiered rates based on water budgets send a pricing signal that discourages wasteful water use.

Box 3-5 Dedicated Water Meters: California Water Code Section 535

Since 2008, water suppliers must install a dedicated landscape meter on new non-residential water service with a landscape area of more than 5,000 square feet. The California Green Building Standards Code requires dedicated meters, metering devices, or sub-meters to facilitate water management on non-residential landscapes from 1,000 square feet up to 5,000 square feet.

Box 3-6 Case Study: City of Sacramento Advanced Metering Infrastructure

After installing advanced metering infrastructure (AMI) in more than 17,600 residences, the City of Sacramento reported the following successes during the two-year period of 2010-2011:

- 1,076 single family homes showed leak alerts.
- 75 percent of leaks were verified in the field.
- 367 million gallons of aggregate annual water loss were calculated through AMI reports.
- 236 million gallons of water were saved, which equates to 12.6 gallons per capita per day.

AMI can play a major component in helping the City of Sacramento reach the State mandate of a 20-percent per-capita reduction by 2020.

—2011 California Urban Water Conservation Council Advanced Metering Infrastructure Symposium, Sacramento

Box 3-7 Multi-Family Dwellings and Sub-Metering

Multi-family units are often served by a single water meter, and the water bill is included as a fixed part of a tenant's rent payment. This makes tracking individual tenants' water use virtually impossible and removes the consumers' incentive to conserve water in response to a high water bill.

When each dwelling unit within a multi-family property is individually metered, this is called sub-metering. A 2004 study (East Bay Municipal Utility District and Aquacraft 2004) found water savings of 15.3 percent when comparing sub-metered properties with rental properties that do not bill water separately from rent.

There are, however, numerous obstacles to capturing these savings, even in new buildings. Meter installation may lead to unacceptable pressure drop at some locations, and vertical plumbing layouts that supply water to each unit through multiple locations may make installation of traditional in-line water meters impractical. Important consumer protection issues must also be addressed if the interests of occupants dealing with water billing service companies are to be fully protected.

Sub-metering in multi-family dwellings could present an opportunity for significant water conservation in the future.

Box 3-8 Process Water

Process water is water used by industrial water users for producing a product or product content, or water used for research and development. Process water is highly specific to each industrial user.

Process water, within certain parameters, may be excluded from calculations of baselines and targets in order to avoid a disproportionate burden on another customer sector.

—California Code of Regulations, Title 23, Section 596

Box 3-9 California Prisons Reduced Annual Water Use by 21 Percent

By implementing a water conservation program, the California Department of Corrections and Rehabilitation (CDCR) achieved an annual water use reduction of 21 percent. The CDCR's water conservation program began in 2006, ramped up in 2008 in response to the drought declaration, and achieved a 21-percent reduction by 2009.

CDCR headquarters issued a document called *Best Management Practices Water Management & Conservation* that covered:

- Eliminating nonessential water use.
- Water-efficient landscaping and irrigation.
- Leak detection and repair.
- Laundries and vehicle washing.
- On-site water consumption surveys.

The CDCR enacted the following measures:

- Toilet flush meters were installed in nearly one-third of all adult institutions.
- Institutions report monthly water consumption to CDCR headquarters.
- Enacted low- or no-cost water conservation methods.

—*California Department of Corrections and Rehabilitation 2009*

Box 3-10 Consumption-Based Fixed Rates, City of Davis

Volumetric water rate structures provide a strong conservation incentive to customers. However, changes in customers' water use can cause a water supplier's revenue to vary, making it difficult to cover fixed costs.

Beginning in January 2015, the City of Davis will begin implementing an innovative rate structure, known as "consumption-based fixed rates." This structure introduces a method that provides revenue stability for the water agency, regardless of the volume of water sold, while also providing a conservation price signal to its customers.

This unique rate structure divides the agency's fixed costs proportionally among all its customers, based on the customers' peak use the previous year. Customers who have implemented conservation measures and reduced their water use will lower the fixed charge on their bill. The agency's variable costs are covered by including a volumetric charge on customers' bills.

More information about the City of Davis' rate structure can be found here: [To be determined].

Box 3-11 Successful Conservation Rate Structure: Irvine Ranch Water District

The rate structure at the Irvine Ranch Water District (IRWD) signals customers when they are exceeding their water budget and signals the IRWD about which customers are in need of attention.

The IRWD sets water budgets for each customer based on a variety of factors, such as the size of a landscape area, the weather, the number of residents, or the industrial or commercial business types. When a customer exceeds his or her water budget, the price per unit of water becomes more expensive. By taking these factors into consideration, the IRWD is able to customize the water budget for each customer and ensure a fair allocation.

The IRWD also charges a monthly fixed charge based upon meter size. The fixed charge covers all operating costs and related water use efficiency programs. The IRWD operates with a stable revenue stream despite variability in the volume of water sold.

Box 3-12 Reducing Irrigation Runoff Helps Local Waterways

Improving irrigation efficiency will prevent irrigation runoff, saving both water and energy and preventing the contamination of receiving waters by landscape pesticides, fertilizers, pet wastes, and sediment.

Sampling of the water quality in urban streams throughout California has found the universal presence of common landscape pesticides, such as diazinon, fipronil, chlorpyrifos, and bifenthrin among others. When excess irrigation water is applied, these pesticides, as well as herbicides, fertilizers, other nutrients, and pathogenic organisms are washed into the stormwater system and local watersheds. These contaminants are toxic to aquatic organisms.

Dry-season irrigation runoff can be prevented by irrigation system maintenance, proper irrigation scheduling, and landscape design. Irrigation scheduling should be appropriate for the site conditions, when factoring in slope, soil type, and the ability of the soil to absorb the water. Incorporation of rain gardens and vegetated swales into a landscape design will also retain runoff from irrigation and rainwater, reducing negative impacts on local waterways.

Box 3-13 Climate Change and Water Use Efficiency: The Energy-Water Nexus

California's energy and water resources are entwined. Energy is used to transport, pump, heat, cool, treat, and recycle water. And water is used to generate hydroelectricity and to cool power plants.

According to the report *California's Water-Energy Relationship* (California Energy Commission 2005), water-related energy use consumes about 19 percent of California's electricity, 88 billion gallons of diesel fuel, and 30 percent of non-power-plant natural gas. Urban water use comprises 58 percent of the total water-related energy consumption in the state.

When water is used efficiently, there is a corresponding savings in energy. Also, because most energy production creates greenhouse gases that contribute to climate change, water use efficiency is a method for mitigating climate change.

In 2004, California Urban Water Conservation Council members who implemented the council's best management practices reported a savings of 27 billion gallons of water. This significant water savings also saved more than 234 million kilowatt-hours of electricity and an estimated $200 million in energy costs.

Box 3-14 San Diego: Comparing Water Source Options

A 2010 study (Equinox Center 2010) comparing the marginal costs of seven alternative water solutions for San Diego concluded that conservation was the most favorable and least costly option.

Table A Cost per Acre-Foot by Water Source

Water source	Cost per acre-foot
Imported water	$875-$975
Surface water	$400-$800
Groundwater	$375-$1,100
Desalinated water	$1,800-$2,800
Recycled water	$1,200-$2,600
Conservation	$150-$1,000

These costs were determined for the San Diego area and would vary for each individual water agency.

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Chapter 17. Matching Water Quality to Use

Matching water quality to use is a management strategy that recognizes that not all water uses require the same water quality. One common measure of water quality is its suitability for an intended use; a water quality constituent often is only considered a contaminant when that constituent adversely affects the intended use of the water. High quality water sources can be used for drinking and industrial purposes that benefit from higher quality water and lesser quality water can be adequate for some uses. For example, a water supplier chooses to use a groundwater source for municipal use, which requires less treatment before delivery, rather than a natural stream. The potential benefit to the municipal user could be reduced disinfection byproducts in the delivered drinking water source and a secondary benefit would accrue to the natural riparian system because water would be left instream. Further, some new water supplies, such as recycled water, can be treated to a wide range of purities that can be matched to different uses. The use of other water sources, like recycled water, can serve as a new source of water that substitutes for uses not requiring potable water quality. Instream uses are directly influenced by discharges from wastewater treatment and stormwater flows and these source discharges can provide benefits and challenges to uses such as aquatic life and recreation.

Matching Water Quality to Use in California

As part of the nine Regional Water Quality Control Boards Basin Planning efforts, up to 25 water quality beneficial use categories for water have been identified for mostly human and instream uses (see Definition of Beneficial Use for Water Quality and Water Rights in the glossary in Volume 4, Reference Guide). For this strategy, the beneficial uses discussed are primarily water quality-related beneficial uses. A second definition of beneficial uses of water is also defined by the California Code of Regulations for the purposes of applying for a water right to appropriate water. These two definitions of beneficial uses overlap, but differ enough so that one needs to be aware of the distinction (see California Code of Regulations, Title. 23, Sections 659-672).

Human uses are categorized as consumptive (e.g., municipal, agricultural, and industrial supplies) and non-consumptive (e.g., navigation, hydropower generation, and recreation). Instream uses include aquatic ecosystem uses, fish migration, spawning, and preservation of rare, threatened, and endangered species. Matching water quality to most of these uses is important because water is generally used as is i.e., without treatment except for municipal and industrial uses. In addition, aquatic organisms are more sensitive to some pollutants than humans. For example, the presence of dissolved metals at low concentrations can be lethal to sensitive fish species.

Matching Water Quality to Agricultural Use

Farmers currently match crops to the available water quality. In general, irrigation water should contain levels of constituents, such as salinity and boron, which will not inhibit the yields of some of the crops. Conversely, agricultural water supplies that have low levels of salts may require adding gypsum to improve percolation. Agricultural water supplies may require filtration to remove particulate matter that could clog low pressure irrigation systems and reduce soil infiltration rates. As an extreme case, Imperial Irrigation District runs all water that it diverts from the Colorado River at Imperial Dam through siltation basins to remove suspended particulates before the water is released into the All American Canal. In setting objectives for the reasonable protection of agricultural use in the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, the Regional Water Quality Control Boards examined the suitability of soils to determine anticipated crop types and set the salinity objectives to meet the needs of these crop types.

Matching Water Quality to Instream and Ecosystem Use

Ambient, instream water must be suitable to support a wide range of aquatic habitats and conditions. Thus, water quality for instream uses generally must meet physical, chemical, and biological objectives specific to the habitat and instream needs. One particular water quality objective that greatly affects fisheries is temperature. An example of an effort made to match water quality to an environmental use for temperature is the Temperature Control Device at Shasta Dam, which was built to make a better match of water temperature to the reproductive needs of salmonid fish downstream. When viewed from a watershed level, decisions about whether to use instream versus out-of-stream sources, such as groundwater and recycled water, to meet future municipal and agricultural demands may result in the decision to leave water instream in favor of using out-of-stream alternatives.

Matching Water Quality to Drinking Water Use

In order to avoid the additional cost of treatment and to provide multiple protection barriers for public health, it is best that drinking water supplies start with the highest quality source water reasonably possible. Historically, California's urban coastal communities—Los Angeles, San Francisco, Oakland, and Berkeley—constructed major aqueducts to sources such as Hetch Hetchy, Owens Valley, and the Mokelumne River. Later, water supplies of lesser quality, such as the Sacramento-San Joaquin Delta and the Colorado River, were also tapped for domestic water supplies. In response, many utilities already manage water quality by blending higher quality water supplies with those of lower quality, as well as matching treatment process to source water quality, as required by regulation. For example, Metropolitan Water District of Southern California (MWD) dilutes high salinity Colorado River water with lower salinity water from the Sacramento-San Joaquin Delta (Delta). This improves the public's acceptance of tap water, as well as facilitating groundwater recharge and wastewater recycling projects. In turn, MWD dilutes the higher bromide and organic carbon levels in Delta water with Colorado River water to help reduce disinfection byproducts in treated water. In Solano County, higher quality, less variable Lake Berryessa water is blended with lower quality, highly variable North Bay Aqueduct water from the Delta. Likewise, many water suppliers have the capability to blend groundwater, local surface water, and imported supplies to achieve a desired water quality, although some utilities may choose to use water supplies based upon cost minimization or water rights considerations instead. Some water agencies even blend water and water quality from different levels of the same reservoir by using different intake levels. Many water management actions, such as conjunctive use, water banking, water use efficiency, and water transfers intentionally or unintentionally result in one type of water quality traded for, or blended with, another.

In the Upper Santa Ana River Water Basin, matching water quality to its effective use has been ongoing through a complex watershed-wide method. With the addition of the Seven Oaks Dam, water quality from the reservoir has improved, while at the same time, effluent flow downstream of the reservoir has increased. By using the increased flow of lower quality effluent for groundwater recharge, the region could increase its dry year sources while using the higher quality reservoir water for direct delivery of water for municipal uses.

Matching Water Quality to Industrial and Commercial Use

Businesses also match water quality to use. For instance, ultra pure water is needed in many manufacturing processes in the Silicon Valley and San Francisco Bay Area. In order to produce ultra pure water, manufacturers prefer higher quality (low TDS) Hetch Hetchy water over Delta or groundwater supplies that are also available in the region. The Central and West Basin Municipal Water Districts offer different qualities of recycled water at different costs that are tailored to different uses, including process water for petroleum refining. At least one concrete plant in San Francisco captures and reuses its low quality stormwater runoff for concrete production. The use of saline water and wastewater for power plant cooling has been promoted by the State Water Resources Control Board described in its Power Plant Cooling Policy adopted on June 19, 1975 (State Water Resources Control Board 1975) and implemented by the Regional Water Quality Control Boards.

Water Quality Exchange Projects

There are potential regional opportunities to exchange water to make a better match of the water quality needs of the constituent service areas. This would result in lower treatment costs and associated energy and greenhouse gas (GHG) emissions.

The CALFED Bay-Delta Program (CALFED) identified two potential water quality exchange projects, the San Joaquin Valley-Southern California Water Quality Exchange Program and the Bay Area Water Quality and Supply Reliability Program, to improve water quality and water supply reliability, as well as disaster preparedness, on a regional basis. These programs could promote matching water quality to water use with potentially no degradation to the ultimate use of the water. For instance, a local water agency in the Bay Area with access to a water supply of relatively lower water quality could fund water recycling or water conservation projects in another agency's service area that has a higher quality water supply in exchange for the higher quality water saved by those projects. This concept is being pursued under the Bay Area Integrated Regional Water Management Plan (IRWMP) — Water Supply and Water Quality Functional Area Document (RMC 2006).

Under the San Joaquin Valley-Southern California Water Quality Exchange Program, MWD is working with both the Friant Water Users Authority and the Kings River Water Association to investigate the feasibility of exchanging water supplies. MWD is interested in these exchanges to secure higher quality Sierra water supplies that could lower their cost of treatment and increase their ability to meet more stringent drinking water quality regulations. In return for participating in the water quality exchange, Friant and Kings are interested in securing infrastructure improvements, financed by MWD, which will increase water supply reliability for their members. In this type of exchange, however, increased salinity levels are the largest water quality issue. If water is drawn from a poorer quality supply and the basin has no outlet, then the salinity level in the groundwater will increase (for further discussion, see Chapter 19, "Salt and Salinity Management," in this volume). This program is still being pursued as part of the September 2006 San Joaquin River Settlement (SJRRP 2009; *NRDC et al. v. Rogers et al*. 2006).

Statutory Language

Several sections of the California Water Code and the California Code of Regulations provide guidance for the use of water, specify legal and regulatory requirements, and therefore define the potential for utilizing this strategy including:

- The use of potable domestic water sources for nonpotable use is considered a waste and unreasonable use if recycled water of adequate quality is available (Water Code Section 13550).
- Existing water rights holders are free to use recycled water, desalinated water, or water polluted by waste to a degree which affects the water for other water quality beneficial uses over their normal higher quality water source, without fear of losing their water right due to non use (Water Code Section 1010).

Potential Benefits

Agriculture

For agricultural and instream uses, water quality matching is an integral part of water quality management because there is generally no treatment of these water supplies prior to their use.

Drinking Water

For drinking water, appropriately matching high quality source waters can reduce the levels of pollutants and pollutant precursors that cause health concerns in drinking water. In addition, less costly treatment options can be used when water utilities start with higher quality source waters. In turn, this increases water supply reliability and assures multiple barriers of protection for public health.

Municipal and Industrial

For municipal and industrial customers, using water high in salinity can damage plumbing fixtures, water-using devices, and equipment all of which increases costs. A 1999 study conducted by the U.S. Department of the Interior and MWD found that for every decrease of 100 milligrams-per-liter in salinity, there is an economic benefit of $95 million annually to MWD's customers (Bookman-Edmonston 1999).

Instream/Ecosystem Benefits

For instream uses, maintaining water temperature suitable for fish and aquatic organisms is an integral part of managing instream water quality for the benefit of the ecosystem. Temperature control devices, as used on Shasta Dam, provide reservoir operators with a mechanism to adjust the water temperature of reservoir outlet flows to meet the needs of the downstream ecosystem better.

Opportunities for Blending of Sources

Improved treated water quality and water supply reliability are also potential benefits of water quality matching for those agencies that have access to a diverse water supply portfolio. One example is the Santa Clara Valley Water District, its retail agencies, and other water suppliers along the South Bay Aqueduct which have access to Delta water, Hetch Hetchy, local surface water, and groundwater. During droughts, seawater intrusion increases the level of salinity, including bromide, in Delta water supplies. In such an event, agencies and regions with water source flexibility could use more groundwater or local surface water, if available, both of which are relatively bromide-free. When water with high levels of bromide is disinfected, there may be additional treatment costs incurred to minimize the formation of potentially carcinogenic disinfection byproducts.

Avoided Treatment Costs

Water that contains lower levels of salinity is a better match for domestic water quality uses and for irrigating salt-intolerant crops such as strawberries and avocados. As previously noted, some agencies blend water supplies to achieve a desired water quality, including salinity levels. If low salinity water supplies are unavailable, water utilities may have to treat high salinity water supplies to achieve a desired water quality. In the Chino basin, utilities already desalinate groundwater for domestic use. In the San Francisco Bay Region, the Zone 7 Water Agency and Alameda County Water District (ACWD) also desalinate groundwater for domestic use. For example, the capital costs alone of ACWD's new groundwater desalting project in Newark were $1.3 million per acre-foot per day of capacity, with operations and maintenance costs of $500 per acre-foot.

No-Cost Water Quality Exchange

In 2003 a no-cost water quality exchange was implemented between the Environmental Water Account (EWA), Kern Water Bank, and MWD. Under the exchange, EWA had purchased groundwater in Kern Water Bank, seeking to avoid a storage fee for leaving the purchased water in the bank. MWD offered to receive EWA's purchased water in exchange for providing the EWA with a surface water supply later in the year when EWA could use the water. MWD benefited from the exchange because it received groundwater supplies with low total organic carbon and bromide levels during a period when MWD was unable to blend total organic carbon levels down with Colorado River supplies.

One example of a no-cost exchange is when an urban water user provides agricultural water users with surface supplies during the peak agricultural water demand period. During these periods, agricultural users would otherwise be forced to use groundwater and might face pumping constraints. In return for access to surface supplies, the agricultural user returns a similar amount of pumped groundwater during the fall-winter period when there is excess groundwater pumping capacity and there are undesirable levels of bromide and total dissolved solids in Delta surface supplies.

In addition to water-supply benefits, the use of Delta water in groundwater recharge and banking operations may provide water quality benefits as well as substantially reducing levels of turbidity, pathogens, and organic carbon upon withdrawal. Recharge and banking will result in better quality water with respect to these pollutants if the water is percolated.

Climate Change

As precipitation patterns change, water scarcity is likely to increase. Increased conflict over how to use available water might arise. Matching water quality to use allows for multiple uses below drinking water standards (and a few above those standards) and could increase water supply reliability for urban systems, agriculture, and the environment. Climate change may have an overall negative effect on water quality; climate change impacts such as sea level rise, droughts, and floods additionally would affect water quality.

Adaptation

Generally, treating less water to higher standards may increase adaptive capacity by increasing supply reliability for drinking water. If, for example, more buildings use recycled water for toilets and irrigation, the overall demand for potable water will decrease, making urban systems more resilient when faced with diminished supplies due to climate change impacts. Taking steps such as changing plumbing codes, increasing recycled water production, and allowing for greater flexibility for agricultural irrigation system water quality can help to protect critical drinking water supplies.

Mitigation

Matching water quality to use has mitigation benefits and drawbacks. There are energy benefits from treating less water to a higher quality than is needed for the intended use. Increased energy use, however, may result from increased treatment of municipal wastewater that is sometimes necessary to make that recycled water available for safe, non-potable uses. Moreover, new distribution infrastructure will be necessary in certain instances, and the construction of that infrastructure would result in GHG emissions.

Linkages to Other Resource Management Strategies

Pollution Prevention

This strategy has a direct link to the pollution prevention strategy because maintaining water to its highest quality through pollution prevention allows greater potential uses of the water. The higher the quality of water, the greater potential there is to match quality to use.

Municipal Recycled Water

Water quality is matched to use when municipal wastewater is treated to recycled water standards for non-potable use such as irrigation. This allows greater flexibility in the use of local water supplies and reduces the amount of potable water needed for a community if recycled water replaces potable water that is used for irrigation.

Salt and Salinity Management

As water is used and reused, the potential for buildup of salts in the water makes the water less suitable for reuse. Salinity management is necessary to preserve the maximum potential uses of the water.

Groundwater/Aquifer Remediation

Matching water quality to use can be used as a management tool for aquifer protection. One example of this is in the Salinas groundwater basin where recycled water will be supplied to agriculture in lieu of groundwater. This in lieu recharge is used to combat further seawater intrusion.

Potential Costs

Water Exchange Costs

CALFED estimated that water quality exchanges could cost nearly $100 million (in 2004 dollars) during Stage 1 implementation. These costs can be broken down into costs to build the infrastructure that matches quality to use, the long-term conveyance costs, administrative costs (negotiation costs), swapping place of use, and institutional costs.

Infrastructure and Conveyance Costs

In most cases, costs for matching water quality to use will also include new conveyance systems to connect source waters different from those currently being used. Matching quality to use involves moving water from where it is available to where it is needed, incurring costs for energy, capacity, and hydraulic losses. These costs can come in the form of incentive payments for participants (e.g., the incentive for the Friant/Kings-MWD programs is MWD's willingness to invest in local infrastructure that will benefit the exchange partners).

Major Implementation Issues

Water Quality Exchanges

Water quality exchanges face similar regulatory, institutional, and third-party impact issues that water supply transfers face (for further discussion, see "Water Transfers," Chapter 8 in this volume). In particular, water supplies are generally governed by place-of-use restrictions that must be addressed when exchanging water supplies. Moreover, water quality exchanges could have adverse third-party impacts such as increasing the salinity of local groundwater, reducing the availability of higher quality instream water needed for fisheries, and limiting agriculture to salt-tolerant crops. These water quality exchanges should be evaluated for their impact on energy use and GHG emissions in addition to the increase in supply and satisfaction of increased demand.

Effluent Dominated Streams

Many streams in California have become dominated by effluent releases from wastewater and storm water releases resulting from diversions of water out of streams and lakes for beneficial human uses. In addition, many streams in the semi-arid West that were naturally and seasonally intermittent or ephemeral have become perennial due to wastewater discharges or nuisance flows from stormwater systems. The conversion from intermittent/ephemeral stream types has changed the type of ecosystem being supported. For example, the native red-legged frog thrives in ephemeral stream systems. When these systems are converted to perennial streams, bull frogs, predators of the red-legged frog, can thrive and expatriate the red-legged frog from its habitat. Water pollution reduction is typically directed at eliminating the discharge of water coming from wastewater and stormwater. This strategy could restore some native intermittent/ephemeral ecosystems, but would also remove the “created” perennial ecosystems. The opposite may occur, where effluent has replaced perennial flows, the removal of the effluent could convert historically perennial systems into ephemeral systems unless natural flows could be restored.

As water is withdrawn from streams and lakes in the rain-fed watershed, effluent discharges have been increasing. While effluent discharges might be seen as replacing the natural sources of water in some watersheds, the timing and quality of the water is much different from natural conditions. For example, the effluent is typically warmer than the natural flow from formerly snowmelt-fed or groundwater-fed streams and may contain more salts and other contaminants. This situation typically benefits nonnative fish species over native species.

Usability of Water

There is often a high cost incurred by water supplies that become either unsuitable for certain uses, or very expensive to use because of contamination. An example is the contamination of water supplies by methyl tertiary-butyl ether (MTBE, a gasoline additive that may cause cancer), which initially closed 80 percent of Santa Monica’s drinking water wells, determined in a study by the Environment California Research and Policy Center (Jahagirdar 2003). This contamination forced the city to increase its dependence on imported water sources and later to install treatment facilities to reduce MTBE levels.

Another example, a study by the University of California, Davis on nitrate contamination in the Tulare Lake basin and Salinas Valley, found that many small drinking water systems in these areas that rely on groundwater have nitrate contamination that exceeds the drinking water standard. One solution that matches water quality to use is to switch from the nitrate contaminated groundwater to surface water (Harter et al. 2012).

Salinity

Agricultural drainage, imported Colorado River water, seawater intrusion in the Delta, and coastal aquifers all contribute to increasing salinity in all types of water supplies which can adversely affect many beneficial uses including irrigation, fish and wildlife, and domestic use. The primary tool to reduce salinity impacts is matching water quality to use because many sources of salinity, such as seawater intrusion, are natural and treatment to remove salinity is relatively expensive. If the source water has less salinity, the discharge after use will also have less salinity. Further, water supplies that are high in salinity increase the cost of recycling or recharging them into aquifers for subsequent reuse. The State Water Resource Control Board adopted a Recycled Water Policy in 2009 (State Water Resources Control Board 2009-0011) that directed the Regional Water Control Boards to develop salt and nutrient management plans. In addition, the Regional Water Quality Control Boards have recognized the need to develop salt management strategies to prevent high quality waters from being degraded due to salt discharges. The Santa Ana Regional Water Quality Control Board has adopted a salt management plan and the Central Valley Regional Water Quality Control Board is working on a salt management strategy.

Operations Criteria for Storage and Conveyance

Most reservoirs and other projects, such as water transfers and the EWA described above, operate to achieve goals and objectives related to water supply, power production, flood control, fish and wildlife protection, and even recreation — but not water quality. In the Delta, there are water quality standards for project operations for salinity and temperature that protect agricultural, instream, and municipal and industrial uses. However, these ambient water quality standards do not reflect water user demand for lower salinity water supplies. Moreover, other parameters of concern for domestic uses, such as pathogens and organic carbon, do not have operating criteria and furthermore, do not have objectives in Basin Plans or discharge requirements in National Pollutant Discharge Elimination System (NPDES) permits.

Upstream and Downstream Partnerships

Few partnerships presently exist between upstream source water areas, downstream water users, and the water users in between that affect water quality, resulting in a critical disconnect in the overall system. Such partnerships could lead to pollution prevention or trading opportunities that could create more efficient water quality protection. For example, a downstream partner with an interest in protecting water quality may wish to pay for projects or initiatives in the upstream partner's area of influence. California encourages these partnerships through grants funded by various bond measures to develop and implement an IRWMP.

Ecosystem Restoration and Drinking Water Supplies

Some ecosystem restoration projects, such as wetlands restoration, may improve habitat and even some aspects of water quality, but at the same time may degrade other aspects of water quality, such as the increase of mercury or organic carbon from a drinking water perspective. The CALFED Ecosystem Restoration program has reviewed this potential conflict in matching water quality to use in the Delta. (California Department of Fish and Game 2009).

Recommendations

1. The State should facilitate and streamline water quality exchanges that are tailored to make better matches of water quality to use, while mitigating any adverse third-party impacts of such transfers, including the increase or decrease in net energy use and greenhouse gas emissions.
2. The State, local agencies, and regional planning efforts should review potential impacts on streams by projects aimed at eliminating discharge of wastewater or causing changes to the natural timing and quality of water and make recommendations on how to mitigate these impacts.
3. The State should facilitate water reuse downstream by encouraging upstream users to minimize the impacts of non-point urban and agricultural runoff and treated wastewater discharges.
4. The State should support the development of salt management plans for all watersheds where salt is a constituent of concern.
5. The State and local agencies should better incorporate water quality into reservoir, Delta, and local water supply operations, as well as facility reoperation and construction. For example, the timing of diversions from the Delta, and thereby the concentrations of salinity and organic car-

bon in those waters, could be better matched to domestic, agricultural, and environmental uses. Alternatively, the timing and location of urban and agricultural discharges to water sources, including the Delta, could also be coordinated with the eventual use of water conveyed by potentially impacted diversions. Facilities conveying municipal and industrial water could also be separated from those conveying water for irrigation.

6. The State, local water agencies, and regional planning efforts should manage water supplies to optimize and match water quality to the highest possible use (e.g., drinking water) and to the appropriate treatment technology.
7. Consistent with the watershed-based source-to-tap strategy recommended in "Pollution Prevention," Chapter 18 in this volume, the State should facilitate systemwide partnerships between upstream watershed communities and downstream users along the flow path in order to find ways to make better matches of water quality to use. Ongoing integrated regional water management planning efforts are facilitating systemwide partnerships to make better matches of water quality to use.
8. The State should support research for solutions to the potential conflicts between ecosystem restoration projects and water quality for drinking water.

Matching Water Quality to Use in the Water Plan

[This is a new heading for Update 2013. If necessary, this section will discuss the ways the resource management strategy is treated in this chapter, in the regional reports and in the sustainability indicators. If the three mentions are not consistent, the reason for the conflict will be discussed (i.e., the regional reports are emphasizing a different aspect of the strategy). If the three mentions are consistent with each other (or if the strategy is not discussed in the rest of Update 2013), there is no need for this section to appear.]

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